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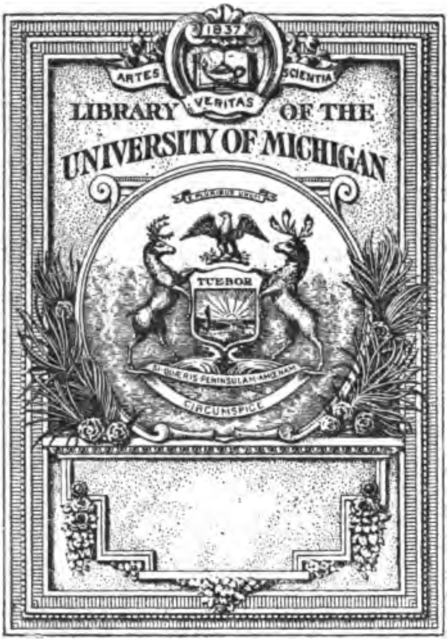

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PROCEEDINGS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY

OF

LIVERPOOL,

DURING THE

SEVENTY-FIRST SESSION, 1881-82.

No. XXXVI.

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Rev. C. S. Armour, M.A.
Alfred Morgan.
Baron L. Benas.

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ON THE SOCIETY'S ROLL AT THE CLOSE OF THE 71ST SESSION.

CORRECTED TO SEPTEMBER, 1882.

Life Members are marked with an Asterisk.

Oct. 21, 1872 Abbott, Joseph, B.A., 2, *Picton-street, Wavertree-road.*

March 24, 1879 Alexander, William, M.D., 102, *Bedford-street South.*

Nov. 1, 1880 Allen, Francis B., 58, *Kremlin Drive, Stoneycroft.*

Nov. 4, 1867 Allen, John Fenwick, *Peaseley Vale, St. Helens.*

Nov. 12, 1877 Allman, G. W., 4, *Ullet-road, Prince's Park.*

March 7, 1864 Archer, F., B.A., Trin. Col., Cantab., *Boundary Cottage, Little Crosby.*

*Nov. 28, 1858 Archer, T. C., F.R.S.E., F.R.SS.A., Director of the Industrial Museum, *Edinburgh.*

Nov. 29, 1880 Armour, Rev. S. C., M.A., Merchant Taylors' School, Crosby.

Nov. 26, 1877 Atkins, H. Norwood, 7, *Hardy-street.*

Nov. 12, 1877 Atkinson, John, *Manchester-street.*

Nov. 13, 1876 Ball, Geo. Hy., *The Priory, St. George's Mount, New Brighton.*

April 20, 1874 Barton, Rev. John, M.A., *Vicarage, Rainhill.*

Oct. 21, 1878 Beasley, Hy. Charles, *Acrefield, Woolton.*

Nov. 15, 1869 Beer, Joseph B. de, *Northern Assurance Chambers, Tithebarn street.*

Feb. 22, 1875 Bellew, Thomas A., *Cunard Mail Office,* 2, *Water-street.*

Nov. 15, 1875 Bellis, William, *Sunny Bank, Victoria Park, Wavertree.*

Jan. 27, 1879 Beloe, Charles H., 16, *Falkner-square*, and 13, *Harrington-street.*

Dec. 10, 1866 Benas, Baron Louis, *Imperial Chambers, Dale-street.*

Jan. 9, 1882 Benas, Phineas A., 74, *Upper Parliament-street.*

Nov. 27, 1865 Biggs, Arthur Worthington, 28, *Exchange-street East*, and 11, *Percy-street.*

Feb. 6, 1872 Biggs, John H. W.

Feb. 6, 1882 Birchall, Charles, 32, *Castle-street.*

Jan. 25, 1864 Birchall, James, *Kirkdale*; HON. SECRETARY.

March 9, 1866 Blood, William, *Chamber of Commerce*, and 47, *Hamilton-road, Birkenhead.*

Dec. 16, 1878 Bogue, Robert Lachlan, *The College, Shaw-street.*

Feb. 18, 1878 Bouch, John, 28, *Berkley-street.*

Nov. 26, 1866 Boult, Joseph, 15D, *Exchange-buildings, W.*

Oct. 19, 1868 Bower, Anthony, *Vauxhall Foundry*, and *Bowersdale, Seaforth.*

Oct. 21, 1872 Bowring, C. T., *Elmsleigh, Prince's Park*, and 20, *Lancaster-buildings, Tithebarn-street.*

Dec. 15, 1878 Brass, Joseph, M.D., 6, *Upper Parliament-street.*

Feb. 6, 1882 Bradley, A. C., M.A., Professor University College, Liverpool, 113, *Canning-street.*

Nov. 4, 1867 Bramwell, Ed., *Cowley Hill, St. Helens.*

Jan. 27, 1878 Bremner, H. H., 15, *Lord-street.*

Nov. 12, 1866 Browne, Edgar A., 86, *Bedford-street South.*

Oct. 18, 1869 Brown, Dr. J. Campbell, D.Sc., F.C.S., *School of Medicine, Dover-street*, VICE-PRESIDENT.

Oct. 30, 1876 Bulman, Richard, 18, *Chapel-street.*

April 18, 1864 Burne, Joseph, *Royal Insurance Office*, 1, *North John-street*, and *Higher Tranmere.*

Oct. 17, 1881 Burton, Dr., 64, *Rodney-street.*

*May 1, 1848 Byerley, Isaac, F.L.S., F.R.C.S., *Seacombe.*

Nov. 3, 1862 Cameron, John, M.D., M.R.C.P., Physician to the Southern Hospital, 4, *Rodney-street.*

Jan. 9, 1865 Cariss, Astrup, *Orange-court, Castle-street.*

Nov. 13, 1876 Carson, Thomas, M.D., 322, *Upper Parliament-street.*

Mar. 4, 1872 Carter, W., M.D.Lond., 74, *Rodney-street.*

Dec. 2, 1861 Chadburn, William, 71, *Lord-street.*

April 3, 1876 Chantrell, G. F., 1, *St. James's Mount.*

Oct. 18, 1869 Cook, Henry James *Byrom-street*, and *Burbo House, Blundellsands.*

Feb. 7, 1881 Cornelius, F. W., *Park House, Waterloo.*

Dec. 13, 1875 Cowell, Peter, *Free Library, William Brown-street.*

Oct. 6, 1863 Crosfield, William, 8, *Temple-court*, and *Alexandra-drive, Ullet-road.*

Oct. 17, 1881 D'Arcy, Nicholas P., *Custom House.*

Nov. 28, 1881 Danger, William, *Orange-court, Castle-street*, and *Liscard Park, Liscard.*

Nov. 12, 1866 Davies, E., F.C.S., F.I.C., *The Laboratory, Royal Institution, Colquitt-street*, PRESIDENT.

Oct. 1, 1866 Dawson, Thomas, 26, *Rodney-street.*

April 6, 1874 Dodd, John, *Cable-street*, and 2, *Derby-terrace, Rock Ferry.*

Nov. 3, 1879 Dopson, Daniel, L.D.S., R.C.S.I., 10, *Oxford-street.*

Nov. 1, 1875 Doyle, Jas. F., 4, *Harrington-street*, and *Merton-road, Bootle.*

Jan. 23, 1848 Drysdale, John James, M.D.Edin., M.R.C.S. Edin., 36, *Rodney-street*, EX-PRESIDENT.

Nov. 1, 1875 Edmonds, William, *Edmund-street Chambers, Edmund-street.*

*Nov. 27, 1848 Edwards, J. B., Ph.D.Gies, F.C.S., Professor Medical Faculty of Bishop's College, *Montreal.*

Mar. 21, 1870 Edwards, Edward E. (Smith, Edwards & Co.), *Adelaide-buildings*, 4, *Chapel-street.*

April 7, 1862 English, Charles J., 26, *Chapel-street*, and 26, *Falkner-square.*

April 20, 1874 English, Robert A., 26, *Falkner-square.*

Nov. 14, 1881	Evans, Geo. Eyre, 100, *Camden-street*, *Birkenhead.*
*Dec. 13, 1852	Ferguson, William, F.L.S., F.G.S., *Kinmundy House*, *near Mintlaw*, *N.B.*
Nov. 15, 1875	Fleming, E. L., F.C.S., *Borax Works*, *Old Swan.*
Oct. 1, 1866	Fletcher, Alfred E., F.C.S., H.M. Inspector of Alkali Works for the Western District, 5, *Edge-lane.*
*Mar. 19, 1855	Foard, James Thomas, 3, *Harcourt-buildings*, *Temple*, *London*, *E.C.*
Nov. 16, 1874	Fothergill, Charles George, 41, *Rodney-street.*
Jan. 12, 1874	Frost, John Pownall, 10, *North John-street.*
Nov. 12, 1877	Galley, Jno., 8, *Newstead-road.*
Nov. 29, 1875	Gardner, William, *Ash Lea*, *Oak Hill Park.*
Nov. 26, 1877	Gatty, Charles T., Mayer Museum, Free Public Museum, *William Brown-street.*
*Feb. 6, 1854	Gee, Robert, M.D. Heidelb., M.R.C.P., Lecturer on Diseases of Children, Royal Infirmary School of Medicine; Physician Workhouse Hospital, 5, *Abercromby-square.*
Mar. 20, 1882	Gill, James, *Sailors' Home*, and 2, *Beech-mount*, *Beech-street.*
Oct. 20, 1879	Gracey, Robert, F.C.S. (Messrs. Cope Brothers), *Lord Nelson-street.*
Oct. 29, 1877	Green, Robt. Frederick, 66, *Whitechapel.*
Nov. 14, 1853	Greenwood, Henry, 32, *Castle-street*, and *South Lawn*, *Great George's-road*, *Waterloo.*
Nov. 16, 1874	Grindley, Benjamin H., *Albion Office*, *School-lane.*
Nov. 16, 1874	Guthrie, Malcolm, J.P., 2, *Parkfield-road.*
Jan. 22, 1855	Hakes, James, F.R.C.S., 30, *Hope-street.*
Oct. 18, 1875	Hale, Philip A., Bank of England, *Castle-street.*
Oct. 21, 1872	Halliwell, Joseph, 10, *College-lane.*
*Jan. 21, 1856	Hardman, Lawrence, 35, *Rock Park*, *Rock Ferry.*
Dec. 13, 1875	Harpin, E., 46, *Onslow-road*, *Elm Park*, *Fairfield.*

Nov. 30, 1874 Harvey, Henry, M.B., *High-street, Wavertree.*

Feb. 6, 1865 Hassan, Rev. E., 2, *Olive Mount, Wavertree.*

Nov. 13, 1865 Hayward, John Williams, M.D., 117, *Grove-street.*

Feb. 6, 1865 Hebson, Douglas, 13, *Tower Chambers*, and 58, *Bedford-street South.*

March 7, 1880 Hess, Leonard O., 51, *Bedford-street.*

Nov. 4, 1872 Hicks, John Sibley, L.R.C.P., 2, *Erskine-street.*

Mar. 22, 1869 Higgin, Thomas, F.L.S., 33, *Tower-buildings*, and *Huyton*, VICE-PRESIDENT.

Dec. 28, 1846 Higgins, Rev. H. H., M.A.Cantab., F.C.P.S., *Rainhill*, EX-PRESIDENT.

Jan. 13, 1879 Higgins, Henry Longuet (Messrs. Simpson & North), 3, *Water-street.*

*Oct. 31, 1836 Higginson, Alfred, 135, *Tulse Hill, London.*

Feb. 18, 1878 Hilton, Benjamin H., Crown Life Assurance, 5A, *Exchange-buildings.*

Nov. 16, 1863 Holden, Adam, 48, *Church-street*, and 2, *Carlton-terrace, Milton-road.*

March 9, 1868 Holme, James, 10, *Huskisson-street*, and *Eldon Chambers, South John-street.*

Nov. 30, 1874 Holme, Rev. Arthur P., *Tattenhall, near Chester.*

*Dec. 14, 1862 Holt, Robert Durning, 6, *India-buildings*, and 29, *Edge-lane.*

April 9, 1877 Hooper, Richard Bennett, 6, *Loudon Grove, North Hill-street.*

Nov. 4, 1878 Howie, J. Muir, M.B., *Rodney-street.*

Feb. 20, 1882 Hughes, J. B., 27, *Percy-street.*

Mar. 10, 1879 Hughes, John W., *Hornby-road, Wavertree.*

Jan. 24, 1876 Hughes, Lewis, 38, *St. Domingo-vale, Everton.*

Feb. 20, 1882 Hunter, Hugh, 25A, *Duke-street.*

*Nov. 13, 1854 Hunter, John, Member Historic Society, Pennsylvania, *Halifax, Nova Scotia.*

*April 29, 1850 Ihne, William, Ph.D.Bonn, *Villa Felseck, Heidelberg*, EX-PRESIDENT.

Oct. 19, 1874 Imlach, Francis, M.D., 153, *Bedford-street South.*

Jan. 26, 1863 Johnson, Richard C., F.R.A.S., 22, *Queen buildings*, *Dale-street*, and 19, *Catherine-street*, Hon. Treasurer.

Oct. 21, 1878 Johnson, John Hampden, 22, *Queen-buildings*, 11, *Dale-street.*

Dec. 15, 1879 Johnson, Stuart M., 79, *Hutchinson-street.*

Feb. 24, 1868 Jones, Charles W., *Field House*, *Wavertree.*

*April 4, 1852 Jones, Morris Charles, F.S.A., F.S.A.Scot., *Gungrog*, *Welshpool.*

Oct. 18, 1869 Jones, William Bolton, 20, *South Castle-street.*

Nov. 30, 1874 Joseph, Rev. Morris, 67, *Canning street.*

Oct. 21, 1878 Ker, R. Wilson, 151, *Bedford-street South.*

Nov. 1, 1869 Kinsman, W. N., *The Tower*, *Sandfield Park.*

Jan. 27, 1879 Kynaston, J. W., 149, *Kensington.*

Oct. 21, 1844 Lear, John, *Stoneby Cottage*, *Stoneby Green*, *New Brighton.*

Nov. 3, 1873 Lee, Hamilton (Messrs. Lee & Nightingale), *North John-street.*

*Dec. 11, 1871 Leigh, Richmond, M.R.C.S., L.S.A., Physician to St. George's Hospital for Diseases of the Skin, 105, *Park-road*, Hon. Librarian.

Nov. 14, 1881 Lloyd, Richard J., B.A., 7, *Castle-street.*

Oct. 31, 1881 Lodge, Oliver J., D.Sc., Professor of Physics University College, 26, *Waverley-road*, *Sefton Park.*

Dec. 1, 1879 Long, Rev. R. E., *Cambridge House*, *Upper Parliament-street.*

Feb. 7, 1881 Lovell, John, 17, *Gambier-terrace*, and "*Mercury*" *Office*, *Wood-street.*

Nov. 1, 1875 Lutschaunig, Alfred, *Blockley's-buildings*, *South John-street.*

April 17, 1865 McCheane, Wm., M.R.C.S., 47, *Shaw-street.*

March 23, 1874 McCulloch, D.B., 28, *Queen-buildings*, *Dale-street.*

Oct. 30, 1876 McGrath, T. J., M.D., *St. James's-road.*

Oct. 17, 1881 McLintock, R., 20, *Great Charlotte-street.*

Nov. 1, 1880 Maitland, H. D.

Jan. 28, 1882 Marcus, Heinrich, *Trafford Chambers*, 58, *South John-street.*

Nov. 14, 1870 Marples, Joseph, 28, *Leece-street*, and *Carlton-road, Tranmere.*

Nov. 17, 1878 Marples, Josiah, *Melvill Chambers*, *Lord-street*, and *Broomfield, Egremont.*

Feb. 19, 1877 Marples, William, 8, *Mathew-street*, and *Alfred-road, Birkenhead.*

Feb. 9, 1874 Marsden, Peter Crook, *Lymefield*, *Heaton*, *near Bolton.*

Jan. 21, 1889 Martin, Studley, 27, *Brown's-buildings*, and 177, *Bedford-street South.*

Feb. 20, 1871 Mason, Alfred H., F.C.S., Lond. and Berlin, 56, *Hanover-street.*

Oct. 20, 1879 McArthur, Charles, F18, *Exchange-buildings.*

Dec. 12, 1881 Medcraft, R., *Plym Villa*, *Trafalgar-road*, *Egremont.*

Nov. 17, 1878 Mellor, James, Jun., *Weston*, *Blundellsands.*

Dec. 14, 1874 Mellor, John, *Stansty*, *Waterloo Park*, *Waterloo.*

Oct. 20, 1879 Mellor, Thomas, *Edgewater*, *Blundellsands.*

Oct. 31, 1859 Moore, Thomas John, Corr. Mem. Z.S.L., Curator, Free Public Museum, *William Brown-street*, VICE-PRESIDENT.

Nov. 15, 1869 Morgan, Alfred, 57, *Seel-street*, and 97, *Hartington-road, Sefton Park.*

Nov. 1, 1880 Morrow, John, 78, *Canning-street.*

March 6, 1882 Morton, Geo. Henry, 122, *London-road.*

Jan. 8, 1855 Morton, Geo. Highfield, F.G.S., 122, *London-road.*

April 16, 1849 Moss, Rev. John James, B.A., *East Lydford Hall*, *Somerton*, *Somerset.*

Oct. 29, 1850 Mott, Albert Julius, F.G.S., *Crickley Hill*, *Gloucester*, EX-PRESIDENT.

April 3, 1854 Mott, Charles Grey, 4, *Cavendish-road*, *The Park*, *Birkenhead.*

Oct. 31, 1881 Mount, Ed., *Brown-hill*, *Lydiate*, *Ormskirk.*

Dec. 16, 1878	Murphy, Rev. P., *St. Anthony's*, *Scotland-road.*
*Oct. 21, 1867	Muspratt, E. K., *Seaforth Hall*, *Seaforth.*
Oct. 20, 1865	Nevins, John Birbeck, M.D.Lond., M.R.C.S., Late Lecturer on Materia Medica, Royal Infirmary School of Medicine, 3, *Abercromby-square*, Ex-PRESIDENT.
Feb. 6, 1865	Newton, John, M.R.C.S., 20, *Marmaduke-street*, *Edge-hill.*
Feb. 18, 1878	Nicholson, Robert, 11, *Harrington-street.*
Nov. 2, 1868	Norrie, Rev. B. A. W., M.A. Cantab., *The College School*, *Huyton.*
*Oct. 15, 1855	North, Alfred, 1, *Hanover-terrace*, *Notting-hill*, *London*, *W.*
Jan. 8, 1877	Ogston, James, *Maresfield*, *Wavertree.*
Dec. 18, 1866	Owen, Peter (Farnworth & Jardine), *Liverpool and London Chambers.*
Nov. 2, 1874	Palmer, John Linton, F.S.A., F.R.G.S., Fleet Surgeon, R.N., 24, *Rock Park*, *Rock Ferry.*
Nov. 28, 1881	Parkyn, Jas., *Beaconsfield*, *Rake-lane*, *Liscard*, *Birkenhead.*
Dec. 15, 1873	Parnell, E. W., 32, *Canning-street.*
Mar. 19 1877	Parry, J. F., *Sandon-terrace.*
Jan. 9 1871	Patterson, J., 16, *Devonshire-road*, *Prince's Park.*
Nov. 4, 1861	Philip, Thomas D., 49, *South Castle-street*, and *Holly-road*, *Fairfield.*
Dec. 28, 1846	Picton, Sir James Allanson, F.S.A., Chairman of the Library and Museum Committee, 11, *Dale-street*, and *Sandy Knowe*, *Wavertree*, Ex-PRESIDENT.
Nov. 1, 1875	Picton, William Henry, *Woodlea*, *Waterloo Park*, *Waterloo.*
Feb. 24, 1879	Plastow, William, 383, *Scotland-road.*
Nov. 15, 1880	Pollard, Dr., 52, *Rodney-street.*
March 4, 1878	Radcliffe, David, 26, *Huskisson-street.*
*Jan. 22, 1866	Raffles, William Winter, *Sunnyside*, *Prince's Park*, and *Glan-y-mor*, *Penmaenmawr.*

Nov. 12, 1860 Rathbone, Philip H., *Liverpool and London Chambers* (H), and *Greenbank Cottage, Wavertree.*

March 24, 1862 Rathbone, Richard Reynolds, 17, *Lancaster-buildings, Tithebarn-street,* and *Beechwood House, Grassendale.*

*Jan. 7, 1856 Rawlins, Charles Edward, 12, *Rumford-court, Rumford-place,* and *Rock Mount, Rainhill.*

Jan. 9, 1870 Rawlins, Gerald W., *Brook Cottage, Rainhill.*

Jan. 7, 1878 Read, Robert, 28, *Berkeley-street.*

Nov. 17, 1851 Redish, Joseph Carter, *Lyceum, Bold-street.*

Oct. 31, 1881 Rendall, G. H., M.A., Principal of University College, 70, *Bedford-street.*

Oct. 31, 1881 Rennie, J. W., 54, *Foxhill-street.*

Nov. 29, 1869 Roberts, Isaac, F.G.S., *Kennessee, Maghull.*

Dec. 4, 1876 Roberts, Richard (Messrs. Roberts & Son), 18, *Hackins-hey,* and *Mossley-hill.*

Nov. 26, 1877 Roberts, J. Geo., L.D.S.,R.C.S.I., 27, *Hope-street.*

Feb. 4, 1867 Robinson, Joseph F., 1, *Apsley-buildings, Oldhall-street.*

Oct. 4, 1869 Rogers, J. Frederick, 7, *Victoria-street,* and 22, *Ullet-road, Prince's Park.*

Jan. 10, 1876 Rogerson, George Russell, F.R.A.S., F.R.G.S., F.R.S.L., *Cook-street,* and *Allerton.*

Oct. 21, 1878 Roose, Edward B., 26, *North John-street.*

Oct. 29, 1877 Rosenheim, Jos. C., *Sunny Bank, Prince's Park.*

April 18, 1854 Rowe, James, 14, *South Castle-street,* and *Leyfield Grange, West Derby.*

Jan. 22, 1872 Russell, Edward R., "*Daily Post*" *Office, Victoria-street,* and 58, *Bedford-street,* EX-PRESIDENT.

Feb. 18, 1878 Russell, W., *Compton Hotel, Church-street.*

April 7, 1862 Samuel, Harry S., 69, *Onslow Gardens, South Kensington, London.*

Nov. 30, 1874 Samuel William H., 145, *Upper Parliament-street.*

Nov. 29, 1880 Sang, Walter, 8, *Brompton Avenue, Sefton Park.*

Oct. 18, 1880 Schack-Sommer, Dr. (Messrs. Crosfield, Barrow & Co.), 328, *Vauxhall-road,* and 72, *Rodney-street.*

March 19, 1866	Sephton, Rev. John, M.A., *Liverpool Institute.*
Dec. 2, 1878	Serjeant, Jno., 128, *London-road.*
Nov. 2, 1868	Sharp, Charles, *Liverpool Institute.*
Jan. 23, 1882	Sharpe, Granville H., F.C.S., *Liverpool College of Chemistry, Duke-street.*
Jan. 7, 1878	Shearer, George, M.D., 173, *Upper Parliament-street.*
Nov. 16, 1868	Sheldon, E. M., M.R.C.S., 223, *Boundary-street.*
Oct. 18, 1875	Simpson, James, 10, *Rumford-place.*
Nov. 4, 1878	Slater, William, 5, *Tithebarn-street.*
Oct. 31, 1881	Smith, A. T., Jun., 5, *Bentley-road.*
Dec. 10, 1866	Smith, Elisha (Henry Nash & Co.), 12, *Tower-buildings North.*
April 4, 1870	Smith, James, 9, *Lord-street* and *Ribblesdale Villas*, 22, *Merton-road, Bootle.*
Feb. 23, 1863	Smith, J. Simm, 1, *Warham-road, Croydon.*
Feb. 24, 1862	Snape, Joseph, Lecturer on Dental Surgery, Royal Infirmary School of Medicine, 75, *Rodney-street.*
Nov. 27, 1877	Snape, Thos., 10, *Kinglake-street, Edgehill.*
April 20, 1874	Snow, Rev. T., M.A., 12, *St. Paul's-square.*
Dec. 2, 1878	Southward, Rev. W. T., M.A., Fellow of St. Catherine's College, Cambridge, *White House, Huyton.*
Nov. 12, 1860	Spence, Charles, 4, *Old Hall-street.*
Feb. 10, 1862	Spence, James, 18, *Brown's-buildings, Exchange,* and 10, *Abercromby-square.*
Jan. 13, 1868	Stearn, C. H., 3, *Newcastle-on-Tyne.*
Nov. 18, 1878	Steel, Richard, 18, *Hackins-hey.*
Nov. 13, 1876	Stephens, Thomas English, *Seafield, Victoria-road, New Brighton.*
Oct. 24, 1876	Stern, Rev. William, D.D., 3, *Hope-place.*
Nov. 1, 1875	Stevenson, John, *Prince Alfred-road, Wavertree.*
Jan. 9, 1865	Stewart, Robert E., L.D.S., R.C.S., 87, *Rodney-street.*

Jan. 9, 1882	Stubbs, Capt. E., R.N., 18, *Greenfield-road, Stoneycroft.*
Nov. 28, 1881	Sumner, R. M., 50D, *Lord-street.*
Nov. 29, 1880	Sword, Patrick, *Aughton, near Ormskirk.*
Feb. 18, 1878	Symes, Charles, Ph.D., *Park Way House, Park Way, Upper Parliament-street.*
April 17, 1882	Tapscott, W. W.
Jan. 23, 1882	Tate, George, Ph.D., F.G.S., F.C.S., Liverpool College of Chemistry, *Duke-street.*
Feb. 18, 1878	Taylor, Geo., 28, *Seel-street.*
*Feb. 19, 1865	Taylor, John Stopford, M.D.Aberd., F.R.G.S., 2, *Millbank-terrace, Anfield-road.*
Nov. 29, 1875	Tetley, John H., *Sunnyside,* 21, *Rock Park, Rock Ferry.*
Feb. 19, 1877	Thacker, Reginald P., *Mandeville, Aigburth-road.*
Oct. 21, 1878	Thompson, J. W., B.A.Lond., 22, *Lord-street.*
March 8, 1880	Tickle, W. H., *Cretan House, Oak Hill Park.*
Jan. 28, 1882	Tilson, R. J., *Ealing, Salisbury-road, Smithdown-road.*
Nov. 17, 1850	Tinling, Chas., *Victoria-street,* and 29, *Onslow-road, Elm Park.*
Dec. 4, 1876	Torpy, Rev. Lorenzo, M.A.
*Feb. 19, 1844	Turnbull, James Muter, M.D. Edin., M.R.C.P., 86, *Rodney-street.*
Oct. 21, 1861	Unwin, William Andrew, 11, *Rumford-place.*
Oct. 20, 1879	Veevers, Samuel, *Huyton.*
Nov. 15, 1880	Vicars, John, 29, *Seel-street.*
Feb. 24, 1879	Walker, R. S., J.P., Resident Secretary, General Insurance Co., 5, *Brunswick-street.*
Mar. 18, 1861	Walker, Thomas Shadford, M.R.C.S., 88, *Rodney-street.*
Jan. 27, 1862	Walmsley, Gilbert G., 50, *Lord-street.*
Jan. 9, 1865	Walthew, William, *Phœnix Chambers,* and *Vine Cottage, Aughton.*
Feb. 19, 1877	Wallace, John, M.D., *Gambier-terrace.*
March 4, 1872	Ward, Thomas, *Brooklands House, Northwich.*

Dec.	2,	1861	Weightman, William Henry, *Minster-buildings*, *Church-street*, and *Cambridge-road*, *Seaforth*.
Oct.	30,	1876	Weightman, Arthur (Messrs. Field & Weightman), *Talbot Chambers*, 3, *Fenwick-street*, *W*.
Dec.	13,	1880	Whitford, Wm., M.D., 37, *Shaw-street*.
April	7,	1862	Whittle, Ewing, M.D., Lecturer on Medical Jurisprudence Royal Infirmary School of Medicine, 77A, *Upper Parliament-street*.
Oct.	17,	1881	Wildig, Rev. G. L. B., M.A., 11, *Gambier-terrace*.
Nov.	14,	1881	Williams, Rev. S. Fletcher, 85, *Everton-road*.
Oct.	31,	1881	Williams, Richard, M.D., 82, *Rodney-street*.
Nov.	2,	1874	Wolf, Jas. O. de (Messrs. T. C. Jones & Co.), 26, *Chapel-street*.
Nov.	14,	1870	Wood, John J. (Messrs. Abraham & Co.), 20, *Lord-street*.
Nov.	29,	1875	Yates, D. E., 9, *Rumford-place*, and 38, *Huskisson-street*.
Nov.	13,	1876	Yates, Edward Wilson, 37, *Castle-street*.
Nov.	2,	1874	Young, Henry, *South Castle-street*.

HONORARY MEMBERS.

LIMITED TO FIFTY.

1.—1833 The Right Hon. Dudley Ryder, Earl of Harrowby, K.G., D.C.L., F.R.S., etc., *Sandon Hall, Staffordshire*, and 39, *Grosvenor-square, London, W.*

2.—1836 The Most Noble William, Duke of Devonshire, K.G., M.A., F.R.S., D.C.L., F.G.S., etc., Chancellor of the University of Cambridge, *Chatsworth, Derbyshire*, and 78, *Piccadilly, London, W.*

3.—1838 Sir George Biddell Airy, K.C.B., M.A., LL.D., D.C.L., F.R.S., F.R.A.S., etc., *Royal Observatory, Greenwich.*

4.—1840 James Nasmyth, F.R.S., *Penshurst, Kent.*

5.—1844 T. B. Hall, *Crane House, Yarmouth.*

6.—1844 Peter Rylands, M.P., *Warrington.*

7.—1844 William B. Carpenter, M.D., F.R.S., F.L.S., Corresponding Member of the Institute of France, etc., *London.*

8.—1850 The Rev. Canon St. Vincent Beechy, M.A., Rector of Hilgay, *Norfolk.*

9.—1851 The Rev. Robert Bickersteth Mayor, B.D., Rector of Frating, *Essex.*

10.—1857 Thomas Joseph B. Hutchinson, F.R.G.S., F.R.S.L., F.E.S., *Ballinescar Lodge, Curracloe, co. Wexford.*

11.—1861 The Rev. Thomas P. Kirkman, M.A., F.R.S., Rector of Croft, *near Warrington.*

12.—1865 The Right Rev. T. N. Staley, D.D., late Bishop of Honolulu, Vicar of Croxhall, *Staffordshire.*

13.—1865 Sir Edward J. Reed, K.C.B., F.R.S., M.P., *Hextable, Dartford, Kent.*

14.—1865 Cuthbert Collingwood, M.A., M.B., F.L.S., 4, *Grove-terrace, Belvedere-road, Upper Norwood, London, S.E.*

15.—1867 J. W. Dawson, LL.D., F.R.S., etc., Principal and Vice-Chancellor of McGill University, *Montreal.*

16.—1868 Captain Sir James Anderson, 16, *Warrington-crescent, Maida Hill, London, W.*

17.—1870 Sir John Lubbock, Bart., M.P., F.R.S., etc., *High Elms, Farnborough, Kent.*

18.—1870 Professor Henry E. Roscoe, F.R.S., etc., *Owens College, Manchester.*

19.—1870 Sir Charles Wyville Thomson, F.R.S., etc., Professor of Natural History, *Edinburgh.*

20.—1870 Sir Joseph Dalton Hooker, M.D., F.R.S, etc., *Kew.*

21.—1870 Professor Brown Séquard, M.D.

22.—1870 John Gwyn Jeffreys, F.R.S., *Ware Priory, Herts.*

23.—1870 Professor Thomas H. Huxley, LL.D., F.R.S., etc., 4, *Marlborough-place, London, N.W.*

24.—1870 Professor John Tyndall, LL.D., F.R.S., etc., *Royal Institution, London.*

25.—1870 The Rev. Christian D. Ginsburg, LL.D., *Binfield, Bracknell, Berks.*

26.—1874 Professor Alexander Agassiz, Director of the Museum of Comparative Zoology, *Harvard, Cambridge, Massachusetts.*

27.—1874 Professor Frederick H. Max Müller, LL.D., *Oxford.*

28.—1874 Sir Samuel White Baker, Pasha, F.R.S., F.R.G.S., etc., *Sandford Orleigh, Newton Abbot, Devonshire.*

29.—1877 Professor F. V. Hayden, M.D., etc., Director of the United States Geological and Geographical Survey of the Territories, *Washington.*

30.—1836 Alfred Higginson, M.R.C.S., 135, *Tulse Hill, London,* also an Ordinary Life Member.

31.—1877 The Earl of Crawford and Balcarres, F.R.S., Foreign Secretary of R.A.S., etc., 9, *Grosvenor-square, London.*

32.—1877 Albert C. L. Günther, M.A., M.D., Ph.D., British Museum.

33.—1877 Adolphus Ernst, M.D., Principal of the Department of Science, Philosophy, and Medicine, University of Caracas.

34.—1877 Dr. Leidy, Academy of Science, *Philadelphia.*

35.—1877 Dr. Franz Steindachner, Royal and Imperial Museum, *Vienna.*

36.—1877 The Rev. H. B. Tristram, M.A., LL.D., F.R.S., Canon of Durham, *The College, Durham.*

37.—1880 Joseph Mayer, F.S.A., *Pennant House, Bebington.*

38.—1881 H. J. Carter, F.R.S., *The Cottage, Budleigh Salterton, Devon.*

39.—1881 The Rev. Thomas Hincks, B.A., F.R.S., *Stokeleigh, Leigh Woods, Clifton, Bristol.*

40.—1881 The Rev. W. H. Dallinger, F.R.S., *Wesley College, Sheffield.*

CORRESPONDING MEMBERS.

LIMITED TO THIRTY-FIVE.

1.—1867 J. Yate Johnson, *London.*

2.—1867 R. B. N. Walker, F.R.G.S., F.G.S., *West Africa.*

3.—1868 Rev. J. Holding, M.A., F.R.G.S., *London.*

4.—1868 George Hawkins, *Colombo, Ceylon.*

5.—1868 J. Lewis Ingram, *Bathurst, River Gambia.*

6.—1869 George Mackenzie, *Cebu, Philippine Islands.*

7.—1870 Rev. Joshua Hughes-Games, D.C.L., King William's College, *Isle of Man.*

8.—1874 Samuel Archer, Surgeon-Major, *Singapore.*

9.—1874 Coote M. Chambers, *Burrard's Inlet, British Columbia.*

10.—1874 Edwyn C. Reed, *Santiago de Chili.*

11.—1874 Millen Coughtrey, M.D., *Dunedin, Otago, New Zealand.*

12.—1875 Robert Gordon, Government Engineer, *British Burmah.*
13.—1877 Edward Dukinfield Jones, C.E., *Sao Paulo, Brazil.*
14.—1877 Miss Horatio K. F. Gatty, *Ecclesfield Vicarage, Wakefield.*
15.—1877 Dr. Allen, *Jamaica.*
16.—1877 Dr. George Bennett, *Sydney.*
17.—1877 Dr. David Walker, *Benicia, U.S.A.*

ASSOCIATES.

LIMITED TO TWENTY-FIVE.

1.—Jan. 27, 1862 Captain John H. Mortimer, "America." (Atlantic.)
2.—Mar. 24, 1862 Captain P. C. Petrie, "City of London," Commodore of the Inman Line of American Steam Packets. (Atlantic.)
3.—Feb. 9, 1863 Captain James P. Anderson, Cunard Service. (Atlantic.)
4.—Feb. 9, 1863 Captain John Carr (Bushby & Edwards), ship "Scindia." (Calcutta.)
5.—Feb. 9, 1863 Captain Charles E. Price, R.N.R. (L. Young & Co.), ship "Cornwallis." (Calcutta and Sydney.)
6.—April 20, 1863 Captain Fred. E. Baker, ship "Niphon." (Chinese Seas.)
7.—Oct. 31, 1864 Captain Thomson, ship "Admiral Lyons." (Bombay.)
8.—April 13, 1865 Captain Alexander Cameron (Boult, English, & Brandon), ship "Staffordshire." (Shanghai.)
9.—Dec. 11, 1865 Captain Walker, ship "Trenton."
10.—Mar. 23, 1868 Captain David Scott.
11.—Oct. 5, 1868 Captain W. H. Cawne Warren, ship "Bedfordshire."

12.—Mar. 22, 1869 Captain Robert Morgan, ship "Robin Hood."
13.—April 29, 1872 Captain J. B. Walker, Old Calabar.
14.—April 29, 1872 Captain Alfred Horsfall, S.S. "Canopus."
15.—Oct. 18, 1875 Captain John Slack.
16.—Feb. 19, 1877 Arthur B. Nevins, Melbourne.
17.—Dec. 2, 1878 Captain C. A. Sibthorpe, S.S. "European."
18.—Dec. 2, 1878 Captain A. T. Cooper, P. S. N. Co.'s S.S. "Illimani."
19.—April 17, 1882 Captain Lecky, R.N.R., F.R.A.S.

VOLUMES PRESENTED TO THE SOCIETY DURING THE SEVENTY-FIRST SESSION, 1881-1882.

A

Antiquaries, Society of, London. List of Members and Fellows, 1881.

Architects, Royal Institute of British. Proceedings, 1880–81, and Charter.

Astor Library, New York. Report, 1880.

Agriculture, Department of, Washington. Report, 1878–79.

Asiatic Society, Royal, London. Journal, vol. xiii.

Anthropological Institute, London. Journal, vol. x.

Astronomical Society, Royal, London. Monthly Notices, vol. xli.

Academie Royale de Belgique, Brussels. Annuaire, 1879–81.

Asiatic Society of Bengal, London. Proceedings, No. 9, 1881.

Akademie du Munschen, Sitzungsberichte der Koniglichen Bayerischen, Philosophisch-philologischen und Historischen Classe, Heften, 1880-81.—Mathematisch-physikalischen Classe, Heften, 1880-1881.—Abhandlungen, und Ueber den geologischen Ban der Libyschen Waste. Munich, 1881.

Archeological Society, Somersetshire, Taunton. Proceedings vol. vi.

Astronomical and Meteorological Observations of the U.S. Observatory, Washington, vol. xxiii., parts 1 and 2.

B.

Botany, Journal of Linnæan Society, London.

Birds, Catalogue of, part v. British Museum.

Births, Marriages and Deaths, Mass., Report on, 1880.

C.

Chemical Society, List of Fellows.

Copernicus, Vereins fur Wissenschaft u. Kunst, Mitteilungen dur. Thorn, Heft. iii., 1881.

Cambridge Union. Annual Report, 1881.

E.

Eclipses, Reports on Total Solar, of July 29th, 1878, and January 11th, 1880, Washington.

Education, Council of, Sydney. Report, 1880.

Essex Institute, Salem, Mass. Report, 1880, and Bulletin, vol. xii.

Engineers, Chief of, Washington. Report, 1879.

Engineers, Institution of Civil, London. Proceedings, 1880-81.

F.

Franklin Institute, Philadelphia. Journal, vol. cxii.

G.

Gottingen, Konigliche Gesellschaft der Wissenschaften, Nechrichten, 1880.

Geologists' Association, London. Proceedings, 1881.

Geological Society, London. Catalogue of the Library. Quarterly Journal, vol. xxxvii.

Geographical Society, American, New York. Bulletin, 1880. Journal, vols. xi. and xii.

Geographischen Gesellschaft, Mittheilungen der, Vienna. Band. xxiii., 1880.

Geological Exploration of the 40th Parallel, by Clarence King, Washington, 1881.

Geological Society, Royal, of Ireland, Dublin. Journal, vol. v.

Geographical Society, Royal, London. Journal, vols. xlviii. and xlix.

H.

Harvard University, Annual Report, 1879-80.—Catalogue of Museum of Comparative Zoology, No. 8. "New and little-known Reptiles."—Memoirs, vols. vi. and vii. Annual Report of Curator, 1879-80-81.—"Bibliographical Contributions" of the University.—Bulletin No. 12, vol. vi. "On the Maturation, Fecundation and Segmentation of Limax Campestris."—Publications of the University, 1870-80.

Heterocera and Lepidoptera, part v. British Museum.

Health, Medical Officer of, Liverpool. Report, 1880.

Henry, Joseph, Memorial of, Smithsonian Institution, Washington, 1880.

Health, Lunacy and Charity, State Board of, Mass. Report, 1880.

I.

India, the Great Trigonometrical Survey of, vol. vi.

K.

Kongliga, Soenska Vetenskaps Akademiens, Stockholm. Handlingar-Band. xv.-xvii., and Atlas.

L.

Literary and Scientific Society, Birkenhead. Report, 1880-81.

Lettres, La Faculté des, Bordeaux. Annales, 1880.

Library, Public, Chicago. Annual Report.

Literary and Philosophical Society, Hull. Report, &c., 1880-81.

Literary and Philosophical Society, Halifax. Report.

Linnæan Society, London. Journal. Botany and Zoology. Proceedings, 1881, and List of Members, 1881.

Lepidoptera and Heterocera, part v. British Museum.

Literary and Philosophical Society of Leicester. Report, &c., 1880-81.

Literary and Philosophical Society of Manchester. Proceedings, vols. xvi.-xix.—Memoirs, vol. vi.

Library, Free Public, Liverpool. Catalogue, part ii., 1871-80.

Literature, Royal Society of, London, vols. xi. and xii.

Limax Campestris, The Maturation, Fecundation and Segmentation of, Harvard University.

Literary and Philosophical Society, Whitby. 59th Report.

M.

Meteorological Observers, Hints to.
Museums, Sydney, Report on, 1880.
Mining Department, Sydney. Report, 1878-79.
Microscopical Society, Royal, London, vol. i., series ii.
Meteorological Society, London. Journal, 1881.
Medico-Chirurgical Society, Royal, London. Transactions, vol. lxiv.
Mathematisch - Naturwissenschaftliche Classe der Kaiserliche Akademie, Vienna, nos. 1 to 28.

N.

Natural Science, Chester, Society of. Tenth Annual Report.
Naturalists' Field Club, Epping Forest. Transactions, vol. i.
Naturalists' Field Club, Liverpool. Report, 1880-81.
Natur, Vereins für, und Heil-Kunde. Verhandlungen, Neul Folge, 4 heff., Presburg, 1875-80.
New Zealand Institute, Wellington. Transactions, &c., 1880.
Natural History, Society of, Boston, Memoirs of, 1881.
Natural Sciences, Society of, Buffalo. Bulletin.

O.

Oversigt Kongelige Videnskabern es Selkab, Copenhagen, 1874-1880.
Odonata, sub-family Æschnina, The Immature State of the, by L. Cabot, Harvard University.

P.

Polytechnic Society, Royal Cornwall. Annual Report, 1881.
Philosophical and Literary Society of Leeds. Report, 1880-81.
Philomathic Society, Liverpool. Report, 1880-81.
Plymouth Institution. Transactions, vol. vii., part 3.
Physischen Libration des Mondes, Strasburg University.
Parallaxe von α Centauri, Strasburg University.

Philosophical Institution, Edinburgh. Report, 1881.
Palæontologia Indica, London, series xv., vol. i., 1882.
Polytechnic Society, Liverpool. Journal, &c., 1881.
Polytechnique, L'École, Paris, tome xxx., cahier 49.
Philosophical Society, American, Philadelphia, vol. xviii.

R.

Royal Society, Edinburgh. Proceedings, 1879-80.
Reptiles, New and little-known, Harvard University Museum of Comparative Zoology, by S. Garman.
Royal Society, New South Wales. Journal, &c., vols. xiii. and xiv.
Royal Institution of Cornwall, Truro. Journal, &c., 1880.
Royal Society, London. Proceedings, 1881.
Reale Instituto Lombardo. Memorie and Rendiconti, vol. xii.
Royal Institution, London. Proceedings, vol. ix., part 3.
Royal Society, Dublin. Scientific Transactions, vols. xiii. and xiv.

S.

Stars, Cape Catalogue of. E. J. Stone, Capetown, 1878.
Snow Storms of January, 1881.
Sciences, l'Académie Royale Suedoise des. Reports, 1877-1881.
Smithsonian Institution, Cambridge, Mass. Report, 1879.
Sciences Naturelles, La Société Nationale, Cherbourg. Catalogue de la Bibliothèque, 1881. Mémoires, tome xxii.
" Scientific Roll, The," London, part 1, 1881.
Salem, Mass., Visitors' Guide to, 1880.
Sciences, des Lettres et Beaux-Arts, l'Académie Royale des, de Belgique, Brussels. Bulletin, tomes xlvi.-l.
Sciences, Société Hollandaise des, Harlem. Archives, tomes i.-xiv.
Sciences, La Société des, de Finlande, Helsingfors, Bidrag, haften 33 and 34—Observations Météorologique, 1878, et Ofversigt, vol. xxii.
Science, Journal of, London, 1881.
Science Gossip, London, 1881.
Statistical Society, London. Journal, vol. xliv.

Sciences, Académie Royale des, Amsterdam, Verslagen en Mededeelingen, Natuurkunde, deel i. to xvi.; Letterkunde, deel i. to x.; also Tria Carmina Latina, and Jahrbock, 1880.

Sciences, New York, Academy of. Transactions, 1882.

Z.

Zoology, Comparative, Illustrated Catalogue of the Museum of, Harvard University, No. 8, New and little-known Reptiles, by S. Garman.

Zoology, Journal of Linnæan Society, London.

Zoological Society, Philadelphia. Report, 1881.

SOCIETIES, ACADEMIES, AND OTHER INSTITUTIONS,

TO WHICH THIS VOLUME IN PRESENTED.

(Donations received this Session from those prefixed with an Asterisk.)

Great Britain and Ireland.

Aberdeen - - - - The Dun-Echt Observatory.
Alnwick - - - - *The Berwickshire Naturalists' Field Club.
Bath. - - - - The Natural History and Antiquarian Field Club.
Belfast - - - - The Naturalists' Field Club.
Belfast - - - - The Natural History and Philosophical Society.
Birkenhead - - - The Free Public Library.
Birkenhead - - - *The Literary and Scientific Society.
Birmingham - - - *The Philosophical Society.
Bristol - - - - *The Naturalists' Society.
Chester - - - - *The Society of Natural Science.
Cambridge - - - *The Union Society.
Dublin - - - - The Royal Irish Academy.
Dublin - - - - *The Royal Geological Society of Ireland.
Dublin - - - - The Royal Society.
Edinburgh - - - *The Botanical Society.
Edinburgh - - - *The Geological Society.
Edinburgh - - - The Meteorological Society of Scotland.
Edinburgh - - - *The Philosophical Institution.
Edinburgh - - - The Royal Observatory.
Edinburgh - - - The Royal Physical Society.

Edinburgh - - - The Royal Scottish Society.
Edinburgh - - - *The Royal Society of Arts.
Falmouth - - - *The Royal Cornwall Polytechnic Society.
Glasgow - - - - *The Philosophical Society.
Glasgow - - - - The Geological Society.
Greenwich - - - The Royal Observatory.
Halifax - - - - *The Literary and Philosophical Society.
Hull - - - - - *The Literary and Philosophical Society.
London - - - - *The Anthropological Institute.
London - - - - *The Society of Antiquaries.
London - - - - *The Royal Institute of British Architects.
London - - - - *The Society of Arts.
London - - - - *The Royal Asiatic Society.
London - - - - *The Royal Astronomical Society.
London - - - - The British Association.
London - - - - *The British Museum.
London - - - - *The Chemical Society.
London - - - - *The Royal Geographical Society.
London - - - - *The Geological Society.
London - - - - *The Geologists' Association.
London - - - - *The Institution of Civil Engineers.
London - - - - *The East Indian Association.
London - - - - *The Linnæan Society.
London - - - - *The British Meteorological Society.
London - - - - *The Royal Microscopical Society.
London - - - - *The Royal Medico-Chirurgical Society.
London - - - - *The Royal Society.
London - - - - *The Royal Institution.
London - - - - *The Royal Society of Literature.
London - - - - *The Statistical Society.
London - - - - *The Zoological Society.
London - - - - *The Editor of "Nature."
London - - - - *The Editor of "The Journal of Science."
London - - - - *The Editor of "Science Gossip."
London - - - - *The Editor of "The Scientific Roll."
Leeds - - - - - *The Philosophical and Literary Society.

Leeds	*The Yorkshire Geological and Polytechnic Society.
Leicester	*The Literary and Philosophical Society.
Liverpool	The Architectural and Archæological Society.
Liverpool	The Chemists' Association.
Liverpool	*The Engineering Society.
Liverpool	*The Geological Society.
Liverpool	The Historic Society of Lancashire and Cheshire.
Liverpool	The Microscopical Society.
Liverpool	*The Naturalists' Field Club.
Liverpool	The Numismatic Society.
Liverpool	*The Philomathic Society.
Liverpool	*The Polytechnic Society.
Liverpool	The Athenæum Library and News Room.
Liverpool	*The Free Public Library.
Liverpool	The Liverpool Library.
Liverpool	The Lyceum News Room.
Liverpool	The Medical Institution.
Liverpool	The Royal Institution.
Liverpool	University College.
Manchester	*The Literary Club.
Manchester	*The Literary and Philosophical Society.
Manchester	Chetham's Library.
Manchester	*The Free Public Library.
Manchester	Owens College.
Newcastle-on-Tyne	*The Natural History Society of Northumberland and Durham.
Oxford	The Ashmolean Society.
Oxford	The Union Society.
Penzance	*The Royal Geological Society of Cornwall.
Plymouth	*The Plymouth Institution.
Taunton	*The Somersetshire Archæological Society.
Truro	*The Royal Institution of Cornwall.
Watford	*The Hertfordshire Natural History Society and Field Club.

Welshpool	*The Powys-Land Club.
Whitby	*The Literary and Philosophical Society.
Woodford	*The Epping Forest Naturalists' Field Club.
York	The Yorkshire Philosophical Society.

British Colonies and the United States.

Bombay	*The Royal Asiatic Society.
Boston	*The American Academy of Arts and Sciences.
Boston	The Massachusetts Board of Agriculture.
Boston	The Massachusetts Board of Education.
Boston	*The Massachusetts Board of Health, Lunacy, and Charity.
Boston	*The Natural History Society.
Boston	The Public Library.
Buffalo	*The Society of Natural Sciences.
Burlington	The Orleans County Society of Natural History.
Calcutta	*The Asiatic Society of Bengal.
Calcutta	*The Geological Survey of India.
Cambridge (*Mass.*)	*Harvard University.
Cambridge (*Mass.*)	*Museum of Comparative Zoology.
Cambridge (*Mass.*)	*The Peabody Museum of American Archæology and Ethnology.
Chicago	The Public Library.
Davenport	The Academy of Natural Sciences.
Melbourne	The Royal Society of Victoria.
New Haven	The Connecticut Academy of Arts and Sciences.
New York	*The Academy of Sciences.
New York	*The Astor Library.
New York	*The American Geographical Society.
New York	The City University.
New York	The State University.
New York	The State Library.

New York - - - The State Museum of Natural History.
Otago - - - - - The University.
Ottawa - - - - The Library of Parliament.
Philadelphia - - The Academy of Natural Sciences.
Philadelphia - - *The American Philosophical Society.
Philadelphia - - *The Franklin Institute.
Philadelphia - - The Pennsylvania Board of Public Education.
Philadelphia - - *The Zoological Society.
Salem - - - - - The American Association for the Advancement of Science.
Salem - - - - - *The Essex Institute.
San Francisco - - The Lick Observatory.
Sydney - - - - *The Royal Society of New South Wales.
Toronto - - - - *The Canadian Institute.
Washington - - - *The Department of Agriculture.
Washington - - - *The Geological and Geographical Survey of the Territories.
Washington - - - *The Naval Observatory.
Washington - - - *The Smithsonian Institution.
Washington - - - *The War Office:—*The Ordnance Department; the Office of the Chief Signal Officer; *the Department of the Chief of Engineers; the Department of the Paymaster-General; the Department of the Surgeon-General.
Wellington - - - *The New Zealand Institute.

FOREIGN.

Bordeaux - - - - La Société des Sciences Physiques et Naturelles.
Brussels - - - - *L'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique.
Cherbourg - - - *La Société Nationale des Sciences Naturelles.
Christiania - - - The University.
Copenhagen - - - *L'Académie Royale.

Copenhagen - - - La Société Royale des Antiquaries du Nord.
Geneva - - - - La Société de Physique et d'Histoire Naturelle.
Gottingen - - - - *Der Königlichen Gesellschaft der Wissenschaften.
Grieswald - - - The University.
Harlem - - - - *La Société Hollandaise des Sciences.
Helsingfors - - - *La Société des Sciences de Finlande.
Königsberg - - - Der Königlichen Physikalisch-ökonomischen Gesellschaft.
Milan - - - - - *La Reale Instituto Lombardo.
Munich - - - - *Der Königlichen Akademie der Wissenschaften.
Paris - - - - - *L'Ecole Polytechnique.
Presburg - - - *Vereins fur Natur-und Heil-kunde.
St. Petersburg - - *L'Académie Imperiale des Sciences.
Stockholm - - - *L'Académie Royale Suedoise des Sciences.
Strasburg - - - - La Bibliothèque Municipale.
Strasburg - - - - *Der Kaiserliche Universitäts und Landes-Bibliothek.
Tokio - - - - *The University.
Vienna - - - - *Der Kaiserliche Akademie der Wissenschaften.
Vienna - - - - *Der Geographischen Gesellschaft.

TREASURER'S ACCOUNT, 1880-1.

Dr. *The Literary and Philosophical Society in Account with* R. C. JOHNSON, *Treasurer.* **Cr.**

1880-1.	£	s.	d.
To Cash paid Messrs. Marples & Co., Printing Volume	132	0	3
" " Messrs. Tinling & Co., Circulars	9	8	0
" " Mr. G. G. Walmsley, Binding	1	7	6
" " Secretary's Expenses	17	14	0
" " " Editorial Fee	10	10	0
" " Mr. Doling, Refreshments	29	5	6
" " Mr. Burke, Attendance	1	10	0
" " Rent of Rooms	20	0	0
" " Librarian's Expenses	4	1	8
" " Treasurer's "	0	19	7
" " F. P. Marratt	15	0	0
" in hand (Dock Bond)	150	0	0
	£391	16	6

1880-1.	£	s.	d.	£	s.	d.
By Balance from last Account, viz:—						
Dock Bond	150	0	0			
Cash in hand	16	13	3			
				166	13	3
" Subscriptions received, viz.—						
11 Entrance Fees	5	15	6			
176 Annual "	184	16	0			
7 " Arrears	7	7	0			
				197	18	6
1 Life Subscription				10	10	0
" Interest on Dock Bond				6	11	8
" Balance due Treasurer				10	3	1
				£391	16	6

Audited and found correct,

ISAAC ROBERTS,
RICHARD STEEL.

PROCEEDINGS

OF THE

LIVERPOOL LITERARY AND PHILOSOPHICAL SOCIETY.

ANNUAL MEETING.—SEVENTY-FIRST SESSION.

ROYAL INSTITUTION, 3rd October, 1881.

EDWARD R. RUSSELL, PRESIDENT, in the Chair.

THE Minutes of the last Meeting of the previous Session were read and confirmed.

The Honorary Secretary read the following

REPORT.

The Literary and Philosophical Society has now completed the seventieth year of its existence; and, if the vitality of its proceedings is accepted as a criterion, the energy is unabated, and the zeal undiminished, with which its members pursue the objects set forth by its founders.

The Meetings of the late Session were well attended—the average number present at each exceeding 80. On two occasions the attendances reached 127 and 171 respectively.

The two Conversaziones in each Session, now devoted to Natural Science, are proving to be of great benefit; and the communications then read from the Corresponding Members and Associates abroad show that these gentlemen are making valuable contributions to knowledge, and doing much to uphold the Society's reputation. The information received in this way, during the late Session, from Mr. Dukinfield Jones and Captain Cawne Warren will be found in the forthcoming Volume of Proceedings.

Hardly less valuable are the inter-communications which precede the reading of the paper at each Meeting. It is by these especially that members at home can manifest their interest in the work of the Society, and show the use they make of such opportunities as present themselves for adding to the sum of human knowledge. The Council believe that some good work was done in this respect during the Session now closed.

Thirteen Ordinary Members have been admitted into the Society since the last Annual Meeting. But during this interval the Society has lost twenty-two members, by death or resignation, so that the roll has been reduced from 246 to 237 Ordinary Members.

Of those now reported as deceased, the loss of Mr. JAMES BIRCH will be felt by many. He was an able and frequent speaker in the debates, and brought to bear upon the questions he discussed the results of an extensive course of reading, and the matured powers of a critical and philosophical mind.

The name of the late Mr. DAVID MARPLES, printer to the Society, also deserves commemoration. He was born at Baslow, in Derbyshire, in the year 1796; and, after an apprenticeship in the office of the *Sheffield Mercury*, came to Liverpool, where, in the course of a few years, he established a business which soon attained a reputation for the taste and excellence of its work. The last sixteen volumes of the Society's Proceedings are fair examples of the productions of his press. Besides being an expert in his art, Mr. Marples was well acquainted with its history and literature; and the papers on these subjects he contributed to the Society's Volume of Proceedings are able and interesting.

A third member who has passed away within the year, is Mr. William Lassell, the astronomer. He joined the Society in 1839, when his reputation as a discoverer, and skilful mechanician in the preparation and construction of reflecting telescopes, was already established. In 1851 he communicated to the Society his discovery of two additional satellites of Uranus; but his removal to Malta in the following year, and subsequent residence at Maidenhead when he returned to England, severed his active connection with the Society; and the observations and discoveries which he continued to make were reported to the Royal Astronomical Society, of which he was President in 1870. An improved machine for polishing specula, completed by him at Maidenhead, after many experiments, is described in the Transactions of the Royal Society for 1874.

Mr. Lassell was a Lancashire man, born at Bolton in 1799. He was a Fellow of the Royal Societies of London, Edinburgh, and Upsala, and was the bearer of many other scientific honours.

The Council turn from these notices of former valued members to express their very hearty satisfaction at the honour of knighthood recently conferred by the Queen upon one of the most accomplished of the Society's living members—Sir James Allanson Picton.

Their satisfaction is greater, from the knowledge that this well-merited distinction has been bestowed upon its recipient as an acknowledgment of his life-long services in the promotion of those objects which this Society was founded to encourage.

Sir James Picton has been a member of the Society for thirty-five years—just one-half the present term of its career; he has been twice elected to the Presidential office, and has contributed no less than nineteen papers to its volumes of Proceedings. No member of the Society has been more regular in attendance at the meetings, or taken a more active part in its discussions and general business. On these grounds alone, the Council feel assured that their colleague and ex-President will be accorded the heartiest congratulations of the Society, with sincere wishes that he may be spared for many years to grace the honour he has received.

The list of Honorary Members has been reduced by the death of Dr. ROLLESTON, Professor of Physiology in the University of Oxford.

To replace this loss, the Council recommend the election of the Rev. W. H. DALLINGER, F.R.S., whose services to the Society are sufficiently known.

The list of Corresponding Members and Associates remains unaltered.

The Council have to report, in conclusion, that the Volume for the last Session will be ready for distribution in the course of the current month.

The Report was adopted on the motion of the PRESIDENT, seconded by Dr. NEVINS.

The HON. TREASURER next presented the Annual Statement of Accounts, which was passed, on the motion of Mr. CHANTRELL, seconded by Mr. EDWARD DAVIES.

The following Officers and Members of Council were then elected:—

Vice-Presidents.—Thos. J. Moore, Cor. Mem. Z.S.L., Thomas Higgin, F.L.S., Professor J. Campbell Brown, D.Sc., &c. Honorary Treasurer.—Richard C. Johnson, F.R.A.S. Honorary Secretary.—James Birchall. Honorary Librarian.—

Richmond Leigh, M.R.C.S.E. Members of Council.—Isaac Roberts, F.G.S., F.R.A.S., Richard Steel, W. Carter, M.D., J. Sibley Hicks, L.R.C.P., George H. Morton, F.G.S., Alfred E. Fletcher, F.C.S., John W. Hayward, M.D., Josiah Marples, George Shearer, M.D., Malcolm Guthrie, J.P., Rev. P. Murphy, Rev. C. S. Armour, M.A., Alfred Morgan, Baron L. Benas.

The Associates of the Society were re-elected.

The Rev. W. H. Dallinger, F.R.S., was elected an Honorary Member.

Mr. Edward Davies, F.C.S., F.I.C., the President elect, then took the Chair, and delivered his Inaugural Address on "Chemical Force."*

FIRST ORDINARY MEETING.

Royal Institution, October 17th, 1881.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Messrs. N. P. D'Arcy and R. McLintock, the Rev. G. L. B. Wildig, and Dr. Burton were elected Ordinary Members.

Mr. Isaac Roberts, F.G.S., read a communication on the Storage of Electricity, by Planté and Faure cells, which were exhibited and experimented with.

The following communication was read :—

ON FRESH-WATER MOLLUSCA FROM LAKE TANGANYIKA.

By the Rev. H. H. HIGGINS.

A series containing about twenty-five species of land and fresh-water shells from the vicinity of Lake Tanganyika was recently offered for sale to the Museum of Liverpool. The land-shells, though most of them had been described as new species, were very similar in form and appearance to those already familiar to collectors. Amongst the shells taken from the waters of the lake were seven forms of considerable interest; and these, when compared with figures of all the species hitherto sent to this country from Lake Tanganyika, seemed to include the whole of the most striking forms. These seven were therefore purchased for the sum of £4 4s. Enlarged sketches of them have been made for the present occasion by Mr. John Chard, and the shells themselves are submitted for your inspection.

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* See page 1.

About twenty years ago a small collection of shells from the Albert Nyanza, and I believe also from Lake Tanganyika, was sent home by Captain Speke. Others followed from the Rev. E. C. Hore, and a larger series from Mr. Joseph Thompson. From these three sources have been derived most of the Central African lake shells now in this country.

Before proceeding to notice certain peculiarities in the specimens exhibited, it may be desirable to give some reasons for regarding them as possessing more than ordinary interest.

Land and fresh-water shells are supposed to be more characteristic of the localities in which they are found than birds or insects endowed with superior powers of locomotion. The tardiness of a snail is proverbial; and the cruel taunt recorded as used against a certain lethargic driver of a diligence—that if he had ever seen a snail he must have *met* one, since he could not possibly have overtaken it—points to a fact bearing on the geographical distribution of the pulmoniferous Gasteropoda. It is probable that land molluscs could not cross a wide river, or survive transportation by the sea. Birds might carry them, but most snails conveyed by birds would be destined to fulfil a purpose other than the propagation of the species. Floods might distribute them to lower localities, but not to lands bordering on the higher waters of a river; and a lofty mountain chain would seem to be an insuperable barrier to the migration of snails.

The land shells in any country might therefore be expected to represent a developmental order dating from remote antiquity; and that this *is* so is indicated by a multitude of specialities which cannot now be noticed.

But the land shells, though so likely to have been preserved, afford scarcely any clue to their predecessors in the geological series. A few Helicidæ, more or less unlike the living representatives of the group, are known from the Tertiary and Recent periods, together with some lacustrine forms; and then, after receding across a prodigious gap, a few small fossils are found in the carboniferous limestone, which might from their appearance be the mineralised tests of molluscs which now live under stones or at the roots of mosses. We all believe in evolution, said Dr. Carter the other day, but the term "missing links" does not fairly describe what is still wanting in the phylogeny of the land snails. What a world there is before us of bit by bit, but always delightful, discovery! If there was not something better still in prospect, it might make one wish for the oriental greeting to come true—"May you live a thousand years."

Let me now endeavour to remove a slur which has been cast on the study of conchology, my old favourite pursuit, though there are other pages in Nature's book that I love better now. It has been the fashion, and is still the fashion in some quarters—notably it is Professor Semper's plan—to disparage the study of the Mollusca by the shells alone. We need not judge of ladies by their bonnets, or of men by the houses they live in; but shells are much more than protective appliances. Every particle of the shell has been held in suspension or solution in the body of the living animal; and there is not even a microscopic character in the shell which has not its corresponding peculiarity in the animal. It is very much to be doubted whether, in all cases, the morphology of the soft parts affords better indications of blood relationship than that of the hard parts. Mr. Marrat has pointed out that, fairly within the pale of the group known as Nassæ, there are important differences in the animals.* It is desirable not to underrate the value of distinctions which are practically accessible. With unlimited powers of observation, the soft parts would be our safest guide, but we have not such powers. Moreover, Nature, not without imitators, in certain cases takes a deal of pains with her externals, bestowing on them superlative but useless beauty in sculpture or in colour. It is frequently thus with shells. Colouring that an artist might envy is covered up in a sheath of felted epidermis, and never seen during the life of the animal. Now, where Nature makes an apparently useless character prominent, it becomes also significant. It may reveal affinities as reliably as does any other part of the science of morphology.

The hidden loveliness of shells seems to show that all the phenomena of biological development are not to be accounted for on the principle of natural selection, or the law of advantage, an admission to which, I believe, Mr. Darwin himself is increasingly inclined to attach importance.

A lepidopterist, taught to discard distinctions of colour in examining the Butterflies and Moths, might as well forego his work altogether. No doubt, if we could only go deep enough, every portion of a living organism implies every other portion; but such a diagnosis is not for the present generation. One word, lest Professor Semper's admirable researches should be deemed to have met with scant appreciation. As a penetrating observer of Nature, Professor Semper ranks very high. His strictures fall heaviest upon the geologists who know but little by examination of the soft parts of the fossil shells which fill their magnificent cabinets. But the geologists are a puissant race, and are in little need of a defender, whether they use the pen or the hammer. These fine shells from Tanganyika are not, I think, tongue-tied, because, so far as I know, the animals have not been critically examined in a living state.

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* See Society's *Proceedings*, vol. xxxiv., 1879–80, Appen. pp. 17–20.

My waning space reminds me that I must bring this short notice to a close.

What are these hitherto unseen forms, and whence came they? Twenty years ago no intelligent eye had ever received the image of such objects. They come as if from another world, and yet they are not entire strangers. The waters which supply Niagara, and those of the great Siberian lakes, cast on their shores forms too similar not to belong to relatives. With my own hands I have taken from the Sea of Galilee, and from the bright stream that rushes from the fountain of Elisha, near to Jericho, shells resembling those of Lake Tanganyika. Once it was suggested that the valley of the Jordan, the Red Sea—then closed at the southern end and filled with fresh-water—the valley of the Upper Nile, and the great African lakes, formed portions of one vast fresh-water lake system in Eocene times. I lay no stress on this conjecture, but my friend Mr. Moore tells me that Dr. Gunther* has shown that the fishes of the Jordan, and those of the Upper Nile, have apparently some affinity.

All the seven species are what is termed new to science, and all have gills for breathing the air contained in the water. *Tiphobia horei* is certainly like nothing in the earth or in the waters under the earth: that it has no proper epidermis shows, I think, that the waters of the lake must be very pure from any kind of free acid. *Neothauma tanganyicense* is like a Paludina, but its size and lengthened anterior canal remind one of shells from North America. *Limnotrochus Kirki* is the greatest gem of all. It seems to mimic *Echinella*, a marine littoral form, and figuratively is miles away from any known fresh-water species. *Melania horei* is a world-wide form, selected because it is so like a shell I found in the Fountain of Elisha. *Paramelania damonis* is a beautiful shell, quite marine in its aspect. *Melania admirabilis*, has been so called, I suppose, because, being a vegetable feeder, it looks so like an animal feeder. Lastly, *Melania nassa* is, if I may so say, absurdly like some well-known forms of *Nassa*, sea-shells and animal feeders. Not a true air-breathing fresh-water species, like our pond-snails, was in the list, though plenty of true air-breathing land-shells were found on the shores of the lake.

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* See *Introduction to the Study of Fishes*, by Dr. Gunther. A. and C. Black, 1880, pp. 227.—See article "Ichthyology," *Encyclopedia Britannica*, vol. xii., 1881, p. 672, by the same; as also Appendix C on the "Fishes of the Nile," in Petherick's *Travels in Central Africa*. London, 1869. 8vo.—T. J. MOORE.

How strange this tendency to the imitation of marine forms, in the very heart of Africa! Are they vestiges of a time when Africa was submerged, and sharks and whales swam over the spot where Ujiji now stands; and, as the land rose, and the waters drained away, did the ancient sea-shells, the Nassæ and Littorinæ, accommodate themselves to less and less of salt in their surrounding element, the former of these, moreover, adopting a vegetable diet; the animals losing their long necks, and their shells becoming rounded in front? If so, we have mollusca placed in one genus, which, in their pedigree, were wide asunder—a converging instead of a diverging pedigree! But, in this case, what becomes of the dogma of monophyletic descent? Or we may suppose that these wonderful shells are the representatives of ages of evolution on the spot; dating from the time when, as Haeckel asserts, the first mollusc was derived from a worm with a body cavity. A single case of fortuitous pseudo-mimicry is conceivable, but the probabilities against it mount up, in a geometric ratio, with every additional distinct point of resemblance. And when several examples occur together, to believe such quasi-mimicry to be the result of chance must be, in a scholastic aspect, very meritorious. It seems to myself that the path of least resistance in which, as some say, we are all compelled to travel, leads to the conclusion that some of these shells from Tanganyika are descended from marine progenitors.

The Rev. H. H. **Higgins** exhibited and made remarks upon some specimens of *Pentacrinus* or Sea Lily, recently added to the Free Museum. They were sent, with various Corallines, Cirripeds, Sponges, etc., at the suggestion of Dr. Martin Duncan, F.R.S., by Mr. Alleyne S. Archer, of Barbadoes, through the kind offices of Sir T. Graham Briggs, Bart., Member of H.M. Council and of the Federal Council of the Leeward Islands.

Dr. **Hicks** read a paper on "The Development of the Sea Hare."

Mr. T. J. **Moore** exhibited a group of specimens of the Coney of Scripture, *Hyrax siriacus*, and their skulls, specially collected for the Liverpool Free Public Museum by Mr. H. Heywood Jones during a visit to Palestine in the spring of 1881.

Mr. **Moore** also exhibited sketches of a specimen, twenty feet long, of a Xiphioid Whale, *Hyperoodon Butzkopf* (*H. rostratus*), captured Sept. 2, 1881, on the Lancashire side of the river Mersey, near Speke, the skeleton of which had been secured for the Liverpool Museum. This makes the fourth capture of this species in the Liverpool district; three others being recorded by Mr. Byerley, in his *Fauna of Liverpool*, 1854, p. 9.

Some rare plants from the Botanic Gardens were exhibited by Mr. **Richardson**, the Curator.

SECOND ORDINARY MEETING.

Royal Institution, October 31st, 1881.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Dr. R. Williams, Professor G. H. Rendall, M.A., Principal of University College, Professor Oliver J. Lodge, D.Sc., of University College, and Messrs. A. T. Smith, E. Mount, and J. W. Rennie were elected Ordinary Members.

Mr. **Walthew** exhibited a Japanese educational work, containing actual specimens of various kinds of woods attached to each page, the names, in Japanese and European characters, being appended to each specimen.

Mr. **Josiah Marples** then read a paper, entitled, "Some Notes on the last months in the Life of Mary Queen of Scots, hitherto unpublished in England."*

THIRD ORDINARY MEETING.

Royal Institution, November 14th, 1881.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Messrs. R. J. Lloyd, B.A., and G. Eyre Evans, and the Rev. S. Fletcher Williams were elected Ordinary Members.

The Rev. **Henry H. Higgins** said that all the members of the Society would be gratified to hear that one of their Vice-Presidents, Dr. Campbell Brown, was, on Nov. 12th, elected to the Professorial Chair of Chemistry in University College, Liverpool.

Mr. **Higgins** exhibited some implements supposed to have been made and used by the native Carib Indians of the Island of Barbadoes. They resembled adzes, and were cut and ground from the shell of *Strombus accipitrinus*, which is common in the West Indies. They had been sent as a present to the Liverpool Museum by Sir T. Graham Briggs, Bart., of Barbadoes.*

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* See page 25.

Mr. **Higgins** called attention to some observations recently made with instruments of great delicacy at Cambridge, showing that, to the depth of many feet, the crust of the earth was constantly subject to tremors, varying in intensity. So sensitive was the reflecting apparatus used, that the indications had to be observed from a distance through a telescope, the slightest change in the position of the observer, if within a few feet of the mirror, producing violent agitations. Mr. Higgins thought that the continuance of these tremors in rocks, through long geological ages, might have affected their internal structure, and might, to some extent, explain the formation of flints in chalk, in which the silica from many thousands of sponges and *Polycistinidæ* must have combined to form one large nodule of flint.

A paper was then read by Mr. **Charles H. Beloe**, M. Inst. C.E., on "The Life-saving Service of the United States of America." †

FOURTH ORDINARY MEETING.

Royal Institution, November 28th, 1881.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Messrs. W. Danger, Jas. Parkyn, and R. M. Sumner were elected Ordinary Members.

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* See report of following Meeting, November 28th, for Notes by Fleet-Surgeon J. Linton Palmer, R.N.; also paper by Rev. G. J. Chester in the *Archæological Journal*, for 1870, vol. 27.—T. J. Moore.

† See page 57.

The following Notes on the Shell Tools from Barbadoes exhibited at the last Meeting by the Rev. H. H. Higgins, M.A., were then read :—

SHELL TOOLS FROM BARBADOES.

By J. LINTON PALMER, Fleet-Surgeon, R.N., F.S.A., F.R.G.S.

At our last Meeting, some implements made of shell were exhibited and commented on by the Rev. Mr. Higgins. Having been led, from their look, to think they were either of aboriginal or pre-historic date, I took the trouble to inquire into their history, and will briefly say what is known about them.

Barbadoes is composed of coralline limestone. There are well-marked terraces of elevation or upheaval. There is neither primary nor secondary rock in the island. If any specimen could be found, it would either have been drifted ashore, entangled in the roots of some tree (as happens in the Radack Archipelago),* or imported by man.

Shell is very abundant—Genera *Cassis, Conus, Strombus,* in particular. *Strombus* is the genus mostly used in Barbadoes.

Fossil shells of the same genera are also found embedded in the limestone, and these were used where tools of greater hardness were wanted. I show one of them.

I beg of you to notice how important is this fact in its bearing on the subject of pre-historic implements.

In Barbadoes, shell was almost exclusively used for tools. In other West India islands—St. Vincent, for example—stone tools are common, and found in great numbers, but no shells, as tools of that kind were not worth being imported.

Some few stone tools have been found in Barbadoes. One of these was in a grave, in which was a skeleton in a sitting posture. Stone and shell were apparently contemporaneous—the wealthier native being able to purchase the more durable and imported element.

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* Humboldt.

It has been stated that, before its occupation by the English in 1650, wandering Caribs, from time to time, were the sole visitors at Barbadoes, otherwise deserted. This mistake is disproved by the quantity of pottery found, and the permanent kilns for baking it, which have been discovered in the island.

The shell-workers liked to work at the entrance of caves, in the sides of gullies formed by rain-torrents, so that they could always find water for grinding.

These tools are of two patterns, one a gouge, the other a chisel; the latter fewer in number. The fossil tools were mostly found at Bridgetown. One form is like a spoon. In every instance the handle of these has been abruptly broken; so it has been surmised that they were fixed into handles of wood. I do not advance my own impression: I simply quote fact.

Heads of weapons made of shell, and serrated at the edges, have also been found.

I wish also to draw your attention to the difference observable in the primæval implements hitherto found in the American continent. The grooved, or gouge, type prevails in the north; the straight edge, or chisel, in the south.

I remarked at our last meeting that I had not had the fortune of finding, in any of the South Sea Islands I have visited, any existing shell-tools, except utensils for culinary purposes; but that I was aware they do exist, though almost in disuse, in the Admiralty, Caroline, and some other groups of islands; and refer you for ample information to the remarks * of that very acute observer, Professor Mosely, of Oxford, who was in the Challenger Expedition.

* Journal of Anthropological Institute.

Professor **Campbell Brown** explained Edison's plan of transmitting writing by electricity.

Mr. T. J. **Moore** exhibited, from the Free Museum, the rostrum, 42 inches long, of a Sword-fish (*Histiophorus*), taken off Rhode Island, U.S.A., which was stated to have measured 17 feet in length.

METAMORPHOSES OF BRAZILIAN LEPIDOPTERA, IN THE FREE MUSEUM.

By E. DUKINFIELD JONES, C.E., Corr. Memb.

The Rev. H. H. Higgins, in fulfilment of his promise made to the Meeting of the Society on the 21st February last,* exhibited a specimen drawer containing the first portion of the above collection, neatly arranged by Mr. J. Chard, to show the larva, pupa, and imago of each species, side by side. This arrangement, which will be carried out for the whole collection, gives the fullest and clearest possible view of the specimens, and the readiest means of comparison with the life-history of each species, given in the copious notes furnished by Mr. Dukinfield Jones, and printed, with illustrations, in the present volume.†

Mr. **Albert** J. **Mott**, F.G.S., read a paper on "The Velocities of Gases."‡

FIFTH ORDINARY MEETING.

Royal Institution, December 12th, 1881.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Mr. H. J. Carter, F.R.S., and the Rev. Thomas Hincks, B.A., F.R.S., were elected Honorary Members.

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* See *Proceedings*, vol. xxxv., 1880–81., p. lxv.

† See page 337. ‡ See page 81.

Mr. R. Medcraft was elected an Ordinary Member.

The Rev. H. H. Higgins, M.A., read the following Note on a Mexican Beetle, used as an amulet, exhibited at the preceding Meeting:—

"At our previous Meeting a Mexican amulet was shown to me by Mr. Russell, the property of a lady who had been presented with it alive when residing in Mexico. It was a beetle, with a belt of gold between the thorax and the base of the elytra, to which was attached a gold chain by which it might be worn. The name of the beetle is *Zopherus Bremii*. It is a Californian species, but probably may be found also in Mexico. The group to which it belongs consists of beetles living in dark places, and remarkable for the slowness of their motions. The nearest British insect is the Cellar Beetle, *Blaps;* not the popular, or rather unpopular, Blackbeetle, or Cockroach, which is not a beetle at all. It is not allied to the sacred beetle of the Egyptians; but an allied beetle is used in Egypt as a specific against the ear-ache and the bite of a scorpion. The golden belt seems modern, but the chain is of very unusually fine gold and of exquisite workmanship."

The Rev. H. H. Higgins also exhibited a few Foraminifera, presented to the Museum by Dr. Carter, F.R.S. They were chiefly Nummulites, from the Eocene.

Mr. Guthrie then read a paper on "Some Imperfections in Professor Balfour Stewart's Statement of the Doctrine of the Conservation of Energy." The principal points to which attention was directed were:—Firstly, the broad distinction drawn between the *Forces of Nature* (viz.: Gravitation, Cohesion, Chemical Force, and Electrical Attraction) and the *Energies of Nature* (eight in number): Energy being defined as the power of doing work against the Forces of Nature. It was pointed out that several of the Energies enumerated are really of the class called Forces, requiring a re-statement specifying what are included in the Conservation of Energy, and what are included in a Conservation of Force, and what is the distinction between the two classes. Within the class of the Conservation of Energy the distinction drawn between Energy of Position and Energy of Actual Motion was examined and criticised. A question was raised as to the Place of Feeling and Will in relation to the Forces of Nature, and more particularly affecting the constant quantity of Energy.

SIXTH ORDINARY MEETING.

ROYAL INSTITUTION, January 9th, 1882.

EDWARD DAVIES, F.C.S., F.I.C., PRESIDENT, in the Chair.

Captain Stubbs, R.N., and Mr. Phineas A. Benas were elected Ordinary Members.

Mr. JOSIAH MARPLES read a Note on the "Historical Errors in Mr. Swinburne's Poem, Mary Queen of Scots." *

Mr. CLEMENTS R. MARKHAM, C.B., F.R.S., Secretary of the Royal Geographical Society, then read a paper on "The Training of Sailors and Explorers." †

SEVENTH ORDINARY MEETING.

ROYAL INSTITUTION, January 23rd, 1882.

EDWARD DAVIES, F.C.S., F.I.C., PRESIDENT, in the Chair.

Messrs. R. J. Tilson, Granville Sharpe, F.C.S., George Tate, Ph.D., F.G.S., F.C.S., and Heinrich Marcus were elected Ordinary Members.

The following communication was read:—

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* See page 54. † See page 105.

NOTES ON THE ABNORMALLY HIGH BAROMETRIC PRESSURE RECORDED DURING JANUARY, 1882.

BY ARTHUR B. NEVINS, F.R.A.S., ASSOCIATE.

DURING the past fortnight meteorological phenomena have been observed sufficiently exceptional in their character to be worthy of notice.

Since the 14th of January the barometer has been abnormally high, and on the 18th January it attained a reading of 30·97 inches, which is the highest on record.

HISTORICAL HIGH BAROMETERS.

In looking back through the records of barometric readings, there are six occasions on which atmospheric pressures have been attained which approach closely to those recently recorded. These have been collected, and published in a letter in the *Times* of the 18th January, by Mr. G. J. Symons, F.R.S.

They are as below :—

	Inches.
January, 1825	30·95
January, 1859	30·83
December, 1865	30·78
March, 1867	30·79
February, 1873	30·83
December, 1879	30·79
January, 1882	30·97*

There is one remarkable fact about the phenomena recorded in the above table, viz., that all these abnormally high pressures have occurred during the winter months.

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* These readings are all corrected for temperature 32° F., and the sea level, except the first, and in the case of that observation it is not known whether these corrections have been applied.

The *mean* pressure in Great Britain is higher by about two-tenths of an inch in summer than in winter, but the highest readings seem always to occur in winter.

CYCLONIC (NORMAL) DISTURBANCES PRECEDING HIGH PRESSURE—ANTI-CYCLONIC DISTURBANCES ACCOMPANYING IT.

During the first week of January, 1882, the weather experienced in the British Isles was the normal winter weather. The atmospheric disturbances which passed over Great Britain came up as usual from the South of West, and passed away to the North of East. They were also *cyclonic* in form, *i.e., the central area* was one of *low pressure,* with isobars of higher pressure surrounding it, increasing as they extended outwards from the central area. The course of the wind round the area of disturbance was also the true, or *normal direction,* being *Westerly on the Southern side,* and Easterly on the Northern side of the area.

During that time, however, an *anti-cyclonic* system of disturbance was forming in central Europe, and travelling up in a direction from S.E. to N.W.

The *central area* was one of *high pressure,* and the isobars surrounding it represented barometric readings decreasing as they receded from the central area of high pressure. The wind also circulated round in this system of disturbance in the opposite direction to that which it takes when the central area is one of low pressure; *i.e.,* the wind was *Easterly on the Southern side,* and Westerly on the Northern side of this anti-cyclonic disturbance.

By the aid of twelve diagrams (copies of the Synchronous Weather Charts of Western Europe, showing the isobaric lines, wind direction and force, etc., at six p.m., which are published daily in the *Times*), the isobaric lines, and corresponding wind directions on twelve days between the 9th and 23rd of January, were shown.

It was thus pointed out that on the 9th of January normal cyclonic atmospheric disturbances prevailed over Western Europe, the N.W^{n} edge of the anti-cyclone being at the same time observed impinging on the Southern portion of the cyclonic movement. At this time, the *centre* of the *anti*-cyclonic movement was over the *Western part* of *Germany*.

On the 11th January, the *anti*-cyclonic movement was spreading to the *Northward*, with its central area nearly *stationary*. The curves of the isobaric lines were deflected on the N.E^{n} side, owing to the proximity of a *cyclonic* disturbance, the *centre* of which was over the *Gulf of Bothnia*, and on the Western side, owing to another cyclonic disturbance making up to the Westward of Ireland.

From the 11th to 16th January the central area of high pressure remained nearly stationary over Northern Gérmany, the N.E. of France, and Belgium. The curves of the isobaric lines in the west of Ireland were on some occasions slightly deflected, marking the impingement of cyclonic disturbances travelling up from the S.W^{d}

On the 17th, the central area of high pressure was over the North of France, and was progressing slowly Westward; and on the 18th it was over the South of England, the highest readings having been attained on this day.

From the 19th to the 22nd, the central area of high pressure remained nearly stationary, though the barometer was falling steadily.

At six p.m. on the 20th, the reading was 30·7 inches, and on the 22nd it was 30·5 inches in the area of highest pressure, which still remained stationary over the South of England.

WEATHER DURING THE CONTINUANCE OF HIGH PRESSURE.

The weather over the whole of Western Europe during this period was very settled; the winds were light, and blowing very steadily in the *anti*-cyclonic direction, the whole system seeming to stand like a stationary mass, against the western side of which cyclonic systems of unsettled weather working up from the South-westward impinged occasionally, and passed away to the Northward, skirting its North-western edge.

The weather in England, generally speaking, during the same period was dull, damp, and foggy, but without rain.

NOTE ON OBSERVATIONS SUBSEQUENT TO THE READING OF THE PAPER.

The above remarks brought the history of this abnormal weather up to the date on which the paper was read. As similar weather continued for some weeks afterwards, making the event even more noteworthy, the subjoined notes are added.

On the 22nd January, the barometer was falling slightly, and after falling to 30·5 inches, it commenced to rise again on the 23rd, and continued to read above 30·5 inches till the 28th January; during all this time the character of the atmospheric movements being distinctly *anti*-cyclonic. On the 29th and 30th, a *cyclonic* disturbance occupied the Northern portion of Western Europe, the anti-cyclonic movement still prevailing over the Southern portion of the area of observation. There was a threatening of bad weather, though none was experienced. These changes had been accompanied by a slight fall of pressure, but on the 31st the barometer rose again, and continued high, the weather being moderate and fine until the 12th and 13th February, on which days a cyclonic disturbance, accompanied by a gale of short duration, and a temporary diminution of pressure, passed over the north of Ireland, and Scotland. On the 14th of February the barometer was again rising, and continued to do so, the atmospheric movements being of a decidedly anti-cyclonic character, and the weather very moderate until the 19th February, when the barometer again attained a reading of 30·8 inches. This pressure was maintained until the 22nd, when the barometer commenced to fall steadily, and by the 27th February, the anti-cyclonic system of disturbance had been replaced by an ordinary and normal cyclonic movement, accompanied by a gale of wind, unsettled weather, and a correspondingly low barometer. This seemed to be the final break up of the abnormal weather, and was succeeded by the usual unsettled weather to be expected in winter.

It will thus be seen that from the 11th January till the 26th February, a period of more than six weeks in the depth of winter, there was in Western Europe a continuance of quite abnormally moderate weather, accompanied by a very unusually high barometer, the only break being for a couple of days, viz., 12th and 13th February. On the other hand, it has been ascertained from ships' reports that very heavy weather was experienced in the North Atlantic at various times during those six weeks, and that these disturbances extended as far to the Eastward as the West of Ireland in some instances.

The Rev. S. **Fletcher Williams** read a paper on "Some Popular Misconceptions of Darwinism."*

EIGHTH ORDINARY MEETING.

Royal Institution, February 6th, 1882.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Mr. Charles Birchall and Professor Bradley, M.A., University College, were elected Ordinary Members.

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* See page 133.

The Rev. H. H. **Higgins** exhibited some specimens of Lepidoptera brought from Queensland, and presented to the Museum by Mr. Reginald Cholmondeley. One of the specimens was a large Moth, *Xylocanthà Staceyi*, not previously brought to this country; and said to be so violent in habits and disposition that, except when bred in confinement, the specimens of it known to collectors are mere wrecks.

Mr. E. **Davies** exhibited a new form of electrical accumulator, discovered by Mr. Henry Sutton, of Ballarat, Victoria. It consists of a copper cell filled with an acid solution of sulphate of copper. In this is immersed a plate of amalgamated lead, kept from coming in contact with the copper. On connecting the accumulator with a source of electricity, either a battery or a dynamo-electric machine, the sulphate of copper is decomposed, copper is deposited on the copper cell, and the lead plate is coated with peroxide of lead. When the liquid becomes colourless, the cell is fully charged. With a cell six inches square and two inches wide, a thin platinum wire was heated to whiteness, and finally fused. A small Rhumkorff's coil was also worked by means of the cell. The cell is much smaller than a Faure or Planté cell of the same power. It is very constant, and is freely put at the disposal of science students by the inventor.

Mr. **Richard Steel** read a paper on "Mental Science in its Quantitative Relations." *

NINTH ORDINARY MEETING.

Royal Institution, February 20th, 1882.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Messrs. Hugh Hunter and J. B. Hughes were elected Ordinary Members.

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* See page 193.

Mr. R. C. **Johnson**, F.R.A.S., gave an account of the identity of the Comet of 1880 with that of 1843 and of 1668. The difficulty was shown of assigning an exact orbit, owing to the fact that, at the only appearance when it was well seen, its trajectory was almost a straight line; for, on account of this, it was well-nigh impossible to determine whether its orbit was elliptical, parabolic, or hyperbolic. Its reappearance in 1880 has shown that the orbit is completed in a shorter time than was anticipated, and has given rise to the theory that the retardation may be so rapid, that it is possible that it may not be able to escape the powerful attraction of the sun at its next return, about the year 1897, or, at the furthest, at the next succeeding return. As its volume was, in 1843, estimated to exceed that of the earth 1,700 times (or more than that of Jupiter), it is not impossible that a collision would cause such an accession of heat that our sun might flare up in the manner in which some temporary stars have recently done, and thus cause the destruction of all life on the earth.

Mr. H. L. **Higgins** read a paper on "The Influence of Literature upon the Growth of Religion and Law." *

TENTH ORDINARY MEETING.

Royal Institution, March 6th, 1882.

EDWARD DAVIES, F.C.S., F.I.C., President, in the Chair.

Mr. George Henry Morton was elected an Ordinary Member.

The Rev. H. H. **Higgins**, M.A., exhibited two specimens of Chalcedony containing liquid, with a movable bubble, and read the following Notes thereon :—

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* See page 157.

"These specimens were brought from Monte Video by Mr. Philip Rathbone. The larger piece contains not less than an ounce of liquid, with a large bubble; the smaller seems to have more liquid in proportion. A third specimen is broken, showing the walls of the chamber to be, in the thinnest part, not more than one-tenth of an inch in thickness. The mineral seems to have been recently discovered; no mention of it being made in Dana's Text-book, 1880. T. W. Rudler, Professor of Mineralogy in the Royal School of Mines, informs me that he has not seen any published description of the Chalcedony enclosing water with a movable bubble. The older mineralogists, after the fashion of zoologists and botanists twenty years ago, seem to have been too busy with the morphology of their 'finds,' and with attaching to them evil-sounding names, to have given much care to the investigation of the conditions under which their costly rarities were developed. I am not a mineralogist, and make the following conjectures with much diffidence. In some cavity deep in the earth, and probably under great pressure, occurred a hollow containing a small quantity of water, above the boiling point, but kept liquid by pressure, and super-saturated with silica. On any diminution of the temperature, which might occur extremely slow, the fall of one degree occupying perhaps long ages, crystallization would set in on all the sides of the hollow holding the liquid; and at the same time would be formed, on the surface of the water, a crystalline pellicle, from which crystals would shoot downwards and inwards. Thus would be formed a cavity enclosed on all sides, and filled with liquid. Layers of opalized quartz—chalcedony—might now be deposited externally upon the roots of the crystals, forming a cell with walls impervious to water or gas. Further diminution of temperature would enable minute quantities of gas contained in the water to assume a gaseous form, and unite in a bubble.

In the broken specimen, the walls distinctly show the radial disposition of the crystals forming the lining, and the stalagmitic character of the outer rind, in which the chalcedony is deposited in layers, like the lamina of an onyx or an agate. In the large specimen, the outer surface is very interesting. It is covered with low tubercles, arranged in circles three-fourths of an inch in diameter, each circle having within it several smaller, similar, concentric circles. The cavity is not strong enough to withstand any considerable bursting pressure from within. It is possible, however, that the shrinkage of the contents of the cavity from cold may have maintained the equilibrium between outside and inside pressures. Although the tank-forming chalcedonies do not appear to have been described, quartz crystals, with minute drops and movable bubbles enclosed, have long been common in all collections of minerals. John W. Judd, F.R.S., in his admirable work on Volcanoes, gives the best, almost the only, description I have seen of them. The liquid may be water, a hydro-carbon, or even carbon dioxide. That it may be the *last* has been proved by spectrum analysis, and by the test that when the crystal is heated to 86° or 90° Fahrenheit, the bubble disappears, that temperature being, of carbonic dioxide, the critical point above which no pressure can keep it in a state of liquidity. Still more remarkable is Mr. Judd's account of miscroscopic cavities containing liquid, in which the bubble is in constant motion, pursuing a spiral track from end to end of the cavity. For the only attempt at explanation of this motion yet given, Mr. Judd's work may be consulted; and no one will regret having read the book from the first to the last page. All the cavities of which Mr. Judd speaks are very minute, and it is evident that the tank-forming chalcedonies are constructed in some manner to which the quartz crystals containing drops can afford no sufficient clue; though, as in my own case, Mr. Judd's beautiful researches may lead at all events to more or less reasonable guesses. Through the kindness of Mr. Rathbone, the smaller specimen, and the equally interesting broken one, have been placed in the Liverpool Museum."

Mr **Walthew** exhibited a copy of the Carnival edition of the New Orleans "*Times-Democrat*" (16th January last), with a pictorial supplement, illustrating the procession got up by the "Knights of Momus," of that city, descriptive of the great Hindoo Epic of the "Ramayana." New Orleans was originally settled by the French, who carried thither certain of their customs, and, amongst these, the celebration of the Carnival. This, in course of years, degenerated into a saturnalia of coarse buffoonery; but, about twenty-five years ago, a society of young men inaugurated an improvement in the custom, and the wild processions of the Carnival have gradually been displaced by magnificent and instructive pageants, somewhat similar to those we read of as promoted by municipalities in the middle ages. Of late years a different theme has been chosen upon each occasion, such as Scott's romance of the "Talisman;" "The products of Louisiana;" "The Realms of Fancy;" "A Vision of Fair Women," &c. This year, according to this illustrated sheet, the great Hindoo epic of the "Ramayana" has been presented in a series of magnificent processional *tableaux*, which, in their designs, combine the characteristic profusion of ornamentation belonging to Hindoo art with a weird and beautiful phantasy in the spirit of the poem itself. The procession consisted of a series of platform vehicles, each drawn by horses, commencing with "The Temple of India," and followed by "The Inspiration of Valniki" (the poet who composed these epics, which were ancient traditions when Alexander watered his horses in the Indus). After these came a series of majestic compositions, illustrating the life and adventures of the demi-god Rama and his wife Sitka. This ancient myth, which may probably signify the struggle between good and evil, or summer and winter, is one of the great classics of Hindooism, and permeates the ideas and modes of expression of the literati of India to the present day.

Dr. NEVINS read a paper on "The Revision of the New Testament." *

ELEVENTH ORDINARY MEETING.

ROYAL INSTITUTION, March 20th, 1882.

EDWARD DAVIES, F.C.S., F.I.C., PRESIDENT, in the Chair.

Mr. Jas. Gill was elected an Ordinary Member.

Dr. POLLARD read a paper on "The Justifiability of Scientific Experiments on Living Animals." †

TWELFTH ORDINARY MEETING.

ROYAL INSTITUTION, April 3rd, 1882.

Professor J. CAMPBELL BROWN, D.Sc., etc., VICE-PRESIDENT, in the Chair.

Mr. E. R. RUSSELL read a short paper, entitled "Fresh Light on 'Romeo and Juliet.'" ‡

Mr. GEO. HENRY MORTON read a paper on "The Primary Colours," illustrated with experiments." §

THIRTEENTH ORDINARY MEETING.

ROYAL INSTITUTION, April 17th, 1882.

EDWARD DAVIES, F.C.S., F.I.C., PRESIDENT, in the Chair.

Mr. W. W. Tapscott was elected an Ordinary Member; Capt. Lecky, R.N.R., F.R.A.S., was elected an Associate.

* See page 257. † See page 219. ‡ See page 179. § See page 249.

Professor Herdman read a paper on "Individual Variation among Ascidians." *

The Rev. H. H. HIGGINS contributed a short paper on "The Individuality of Antimers."

The following communication was then read :—

ON A TYPICAL COLLECTION OF SPONGES, AND ON THE "ARGO" SPONGES, IN THE LIVERPOOL FREE MUSEUM.

BY THOMAS HIGGIN, F.L.S.

It will be in the recollection of the Members of this Society that Mr. H. J. Carter, F.R.S., of Budleigh-Salterton, visited the Liverpool Museum in October last, for the purpose of looking over the collection of Sponges, and of explaining the system on which he had arranged the British Museum collection. His time, whilst in Liverpool, was almost wholly devoted to the object of his visit, and the trays which are exhibited this evening are the outcome of it.

They have been arranged to show typical examples of the *Orders*, *Families*, and *Groups*, into which the whole Class of Sponges has been divided, and will be useful to the collector and student, by showing at a glance the why and the wherefore of the divisions, the differences as regards outward appearance, and the microscopic characters of skeleton and spicules, which have influenced the arrangement.

Mr. Carter has made a special study of Sponges for more than forty years. When in Bombay, in 1847, being convinced of the animality of Sponges, he determined to make it a subject which *must* have a place in lectures on Comparative Anatomy, and has lived to see his wish accomplished. In 1857, whilst still at Bombay, he published, in the *Annals and Magazine of Natural History*, a paper "On the Ultimate

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* See page 313.

Structure of the Fresh-Water Sponges," which has proved to be his most valuable contribution to the knowledge of the Class, and he had the gratification of seeing his work thus alluded to by the late Prof. H. James-Clark at a meeting of the Boston Natural History Society, in 1868. (*Ann. and Mag. of Nat. Hist.*, 1868, vol. i., p. 134) :—" Of late years, Carter has made some special investigations in reference to this subject (*Spongiæ ciliatæ* as *Infusoria flagellata*), and, in fact, he has been the first to present anything like decisive proofs of the animality of Sponges."

Again, in 1872, the following appears in the *Proceedings* of the Royal Society, in the President's address.* Addressing Professor Stokes, the Chairman said, " In the absence of Mr. Carter, I have much pleasure in delivering to you, for transmission to him, the medal awarded to him by the Council of the Royal Society, in acknowledgment of his long-continued and valuable services to Physiology, and more particularly of his creating an almost new science as regards the *Spongiadæ*."

Mr. Carter's attention was probably first drawn to this subject during his studies under the late Prof. R. E. Grant, who, in 1826, published in the *Edin. New Philos. Journal*, a very full account of the development of the embryo of *Halichondria panicea*, a common marine species; and subsequently, through his staff appointment at Bombay, which gave him leisure to study the subject that he particularly desired to investigate.

On his return from India, the late Dr. J. E. Gray induced him to undertake the examination of the chaotic collection of sponges in the British Museum, for it had been found impossible to make any practical use of the classification which had been proposed by Dr. Bowerbank. For this purpose the entire collection was sent to him to Budleigh-

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* Sir George Biddell Airy, K.C.B., President, in the Chair.

Salterton, where it remained for a year or two, during which time Mr. Carter examined, figured, numbered and described, in note books opened for the purpose, every single specimen, and then proceeded to arrange them in groups according to the different features presented by outward form, skeletal structure, spiculation, &c. After Dr. Bowerbank's death the British Museum purchased his collection, and Mr. Carter in the same way went through these specimens.

Mr. Carter having had such unusual opportunities for the study of the Class, and being so eminently able to make the best of them, it was thought most desirable that the sponges in the Liverpool Museum should be classified according to the system adopted for the national collection; and therefore Mr. Carter was asked to visit Liverpool, in order that examples of the various groups should be selected by him. This was done during his visit in October last, and the Museum now possesses a collection of examples typical of the different orders, families, and groups, selected by himself.

The small examples contained in the glass-topped boxes have been cut or selected from the large and whole specimens selected by Mr. Carter; and in some cases where specimens were not found in the local collection, examples have been provided by Mr. Carter from his own cabinet.

Our warmest thanks are due to Mr. Carter for the readiness with which he responded to the request that he would visit Liverpool, and for the great interest and extreme kindness he has shown in making his visit as valuable as possible.

I have thought that this short account of the origin of the trays placed before you this evening would be necessary to enable you to appreciate the value of them. In arranging them I have had the cordial co-operation of our friend Mr. Moore and his assistants, but must mention the name of Mr. John Chard in particular, who has done the lettering of the trays in a way that must give general satisfaction.

It will be seen that first we have a typical example of each *order*, next we have typical examples of each *family* into which the order is divided, and lastly we have typical examples of each *group* into which the different families have been divided. Spaces have been provided for illustrations of the microscopic characters of each principal division, and in this part of the work I have been aided by my daughters, who have made the drawings from preparations shown by the microscope, from portions selected by myself as suitable examples; and I may say that the features of each have been as faithfully pourtrayed as was possible without colouring, which, for other reasons as well as for the sake of uniformity, it was decided to dispense with.

The series is comprised in three baywood trays or drawers, of the usual size adopted for the Museum collection of Invertebrata, measuring 29 inches by 18 inches, and 3 inches deep.

The arrangement commences with the *Carnosa*—sponges which have no evident skeleton; and first in order are placed those which not only are without skeleton, but have not even any spicules. Then follow those which have spicules in greater or less abundance scattered throughout the soft parts.

The next order is *Ceratina*—sponges which have a horny skeleton, more or less hollow, cored with a soft, whitish granular matter. In this division the sponges are arranged in families, according to the greater or less hollowness of the fibre. The sponges in this order gradually pass into the next—the *Psammonemata;* for, in addition to the granular axis, we find species whose skeleton or fibre is also cored with grains of sand and other foreign objects, which is the peculiar feature of the *Psammonematous* or sand-sponges.

The order *Psammonemata* commences with the sponge of commerce, in which the grains of sand are almost entirely absent; and it is divided into families according to differences of skeleton, depending mainly on the quantity of foreign objects introduced into the fibre; so that at one end we have sponges almost entirely free from sand, etc., and at the other end, sponges whose skeleton structure is simply a network of ropes of sand, in which the sand grains are agglutinated together with such a small quantity of horny material, that when denuded of the soft parts and dried, the whole sponge can be reduced to a handful of fine sand by very slight pressure or squeezing, a character which induced Dr. Johnston to give the species the name of "fragilis."

All divisions are of course empirical, for I need not say to you that no such divisions exist in nature, and consequently we are prepared to find the sand-sponges gradually passing into the rhaphidonematous sponges, or those whose fibre is cored with spicules like rhaphides. At the end of the order, therefore, are placed those sponges which not only take up grains of sand and other foreign objects from the wash of the sea, and embrace them in their skeleton structure, but which also produce spicules themselves for skeletal purposes.

The order *Rhaphidonemata* contains the sponges whose skeleton fibre is cored more or less with spicules proper to the sponge, or, in other words, produced by the species. This is a very numerous division, and is separated from the *Holorhaphidota*, or sponges whose skeleton structure is made up almost entirely of proper spicules, by an empirical line; and between the two Mr. Carter has introduced the order *Echinonemata*, to embrace all sponges whose skeleton structure is more or less echinated with spicules proper to the species. The last two orders are the *Hexactinellida*, or sponges with six rayed spicules; and the *Calcarea*, whose spicules are composed of calcium.

It is not to be expected that this system or any other will satisfy everybody, but it is perhaps the best that can be adopted in the present state of our knowledge of the Class, and whatever advances may be made in time to come (and we way expect very much to be done in the near future), all will admit the desirableness, indeed the necessity, of having some system to work upon. And I am satisfied that future students and observers will find their work much facilitated by having a typical collection to refer to, selected by the author of the system here adopted.

Mr. Carter, in his latest communication on the sponges collected by the Rev. H. H. Higgins in the "Argo" Expedition to the West Indies, in 1876,* says as follows:—"I propose to identify those already known, and to name and describe those which hitherto have not been published, availing myself at the same time of this opportunity to couple with these descriptions general and classificatory remarks, aided by descriptions and references to species in the British Museum and elsewhere which will best illustrate the subject, thus endeavouring to heap up still more matter for someone to embody in a 'Manual of the Spongida,' based, if he should think fit, on my 'Notes Introductory to the Study and Classification of the Spongida' (*Annals*, 1875, vol. xvi., p. 1, &c.), since it is useless for me to commence a work of this kind now, which I can never expect to complete. Had I had, twenty years ago, the amount of knowledge of the Spongida which the opportunities and time of the last twenty years have given me, I might have done this myself, and more; but as it is, it must be left to the next generation."

From the above we learn that Mr. Carter regards the work he has accomplished as so much contributed during his lifetime towards a more complete treatment of the subject by-and-by, and not by any means as a final and fixed arrangement which future investigations cannot in any way modify.

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* See *Annals and Magazine of Natural History*, for April and May, 1882, pp. 266–301, and pp. 346–368, for two articles, entitled "Some Sponges from the West Indies and Acapulco, in the Liverpool Free Museum, described, with general and classificatory remarks. By H. J. Carter, F.R.S., &c., Plates XI. and XII," containing notes and descriptions of Sponges of the "Argo" Expedition, and Sponges collected and presented to the Free Museum by Capt. W. H. Cawne Warren, Associate of the Society.—T. J. Moore, Curator.

Dr. HICKS exhibited a specimen, from the Museum Aquarium, of the free-swimming stage of a Jelly Fish, and also (under the microscope) a monstrosity of the embryo Chick at the thirty-sixth hour of incubation.

Mr. T. J. MOORE exhibited the following from recent additions to the Free Public Museum, lately brought from the River Plate by Mr. P. H. Rathbone:—

Specimens of Salt-water Fish and Land and Fresh-water Shells, from Monte Video, collected by Mr. J. F. Bourse.

Fossil remains of *Glyptodon* and other extinct Mammals, from Frey Bentos, Banda Oriental, presented by Mr. C. Croker. A small box of Fossil Mammalian Bones, collected at the Cerro, Monte Video, by Mr. Conrad Möller.

PAPERS READ.

CHEMICAL FORCE.

By EDWARD DAVIES, F.C.S.

The contemplation of the forces of nature seems to have been one of the earliest exercises of the human mind. Admiration of force leading to its eventual deification is natural to the savage, with whom the rule of the strongest is a universal law. To worship the sources of power greater than that possessed by mortals—the sun whose genial heat gave life to nature, the winds which could sweep away the frail dwellings which protected him, or tear up the forest trees, the waves whose resistless force threatened to swallow up the solid earth—was to be expected from those whose chief was the strongest man of the tribe. Even when intellectual power began to assert its predominance over brute force, it did so at first solely because it was more powerful, cunning was more than a match for strength, and the worship of wisdom was only another form of the worship of force.

When man at first began to investigate the mystery of nature, no doubt the facts lying on the surface engrossed his attention. Ore was smelted, and the metal obtained applied to man's use many a time before speculation sought to explain its production. As time rolled on men endeavoured to find out the causes of the phenomena which they witnessed, and gravitation, electricity, magnetism, heat, light, and the action of living beings were scrutinised to explain the mighty works we see in the heavens and the earth. Chemical force was one of the last to reveal itself as a mighty factor in the world of nature. Until chemistry brought to light the complex constitution of material objects, there was no basis for theory as to the way in which that complexity arose, and in the days of alchemy supernatural agencies were fondly imagined as superintending the formation of minerals in the earth, and even aiding the operations in the laboratory. Thus, Basil Valentine says, "That the first beginning to beget metalline seeds is wrought in the earth by a sidereal impression; which quality presseth from above into the æther in the earth, and worketh continually a heat there with the help of the elements, for both must be together: the earthy affords an imagination that the earth is fitted for conception, and is impregnated, the elements nourish and feed this fruit, and bring it on by a continued hot quality into perfection; the earthy substance affords a form thereunto, thus at the beginning the metalline and mineral seed is effected, namely, by an astral imagination, elemental operation, and terrestrial form; the astral is heavenly, the elementary is spiritual, and the earthy is corporeal; these three make of their first centre the first essence of the metalline seed."

A more poetical form of the same idea is that spiritual beings, gnomes and sylphs, inhabited the interior recesses of the earth and watched over the growth of minerals, and sometimes they aided the miner, but more frequently they were his enemy. A relic of this past fancy survives in the name of the metal cobalt, derived from Kobold, a mine demon who used this metal to deceive the unlucky miner.

The idea of supernatural force in connection with chemical operations was connected with the theory of the transmutation of metals. The possibility of a total change of properties, with a substance remaining unchanged, was more miraculous to the alchemist than it is to ourselves with the phenomena of allotropism before us. Yet they believed that it might be brought about, though scarcely by purely human means; so, according to the religious temperament of the man, he asked the aid of the Deity, as in Basil Valentine's oftrepeated invocations of the Trinity, or sought demoniacal help, and would have sold his soul to the Devil for the Philosopher's Stone, if such a bargain could be made.

Older views were more philosophical than these. In a treatise on Philosophy, called the Vaiséshika, by Kanada, an Indian sage, who probably lived some centuries before the Christian era, substance is divided into nine divisions—1, earth; 2, water; 3, light; 4, air; 5, ether; 6, time; 7, space; 8, soul; and 9, mind. Of these the first four and the ninth are affirmed to be formed of atoms. These atoms are round, extremely minute, invisible, incapable of division, eternal in themselves, but not in their aggregate forms. They have individually a specific difference. Light, for example, is formed by the aggregation of luminous atoms. Other substances are formed in a similar manner. These atoms combine by twos in an aggregate, or by threes. They also combine by fours, &c. They are innumerable in extent, and are perpetually united, disintegrated, and reintegrated by an unseen peculiar virtue or force—*adrishta.* What idea Kanada intended to convey by this term, adrishta, the unseen, it is not possible to say. He may mean a force, or "potentiality," inherent in the atoms themselves.*

The terms earth, water, and air are probably used, as they were by other early philosophers, to indicate the solid, liquid, and gaseous form of matter. That all solid matters, although supposed to consist of earth, were not identical, was evident to any one, so the difficulty was met by a supposition that "qualities" might be attached to the "earth," and thus bodies endowed with varied properties be derived from the original elementary bodies. "Kanada recognised seventeen qualities—colour, savour, odour, tangibility, number, extension, individuality, conjunction, disjunction, priority, posteriority, intellections, pleasure, pain, desire, aversion, and volition. To these his followers added the seven following:—gravity, fluidity, viscidity, self-reproduction (including motion, elasticity, and memory), sound, with merit and demerit." Many of these refer to the soul, which he considered as a substance, but most of the physical properties of bodies are included in the list.

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* *Hindu Philosophy*, by John Davies, M.A. Trubner's Oriental Series.

The description of atoms and their combinations might have been taken from a modern chemical treatise. If he meant that the force which causes them to combine is inherent in the atoms, he held a view almost the same as that taught by the earlier chemists under the name of affinity. This view is now attempted to be set aside in favour of the theory that forces not necessarily inherent in the atoms bring about their combinations, and that these forces are electricity and heat. These views are those which I propose to examine, and to the former and older one I am disposed to give the preference.

It may be useful to those who have not studied the science of Chemistry, and to those whose knowledge of it was acquired a long time since, if I give an outline of the theory of the constitution of matter as held by chemists of the present day, or, at least, by the majority of them who accept Dalton's Atomic Theory.

All matter is supposed to consist of atoms, defined as exceedingly minute portions of matter, indivisible by any known chemical or mechanical means, and the smallest quantity of an element which can enter into the composition of a compound. These atoms are of very different weights, varying from a relative weight of 1 for Hydrogen to 240 for Uranium, but all the atoms of the same element are of the same size and weight. In the majority of cases atoms of different elements appear to occupy equal portions of space, either being of the same size, or having more or less intervening space between them, so that the atom and the intervening space together occupy equal portions of space. The atoms of an element, with certain exceptions, such as mercury, cadmium, and zinc, do not exist separately in the free state, but are joined together probably in pairs, and in some cases in fours. These groups of atoms, whether composed of atoms of the same element, or of different elements, are called molecules, and are the smallest portions of an element or of a compound which can exist in the free state. Thus representing the atom of the element hydrogen by the symbol H, the molecule is 2 H, or as it is generally written, H_2, and if the atom of chlorine is represented by Cl, 2 Cl, or Cl_2, is its molecule. If hydrogen and chlorine unite or combine together to form hydrochloric acid, the smallest particle which can exist must be represented by HCl, or one atom of hydrogen and one atom of chlorine united form a molecule of hydrochloric acid. A considerable force holds the atoms of a molecule together, although this force varies to an enormous extent, and this force, whether exerted between atoms of the same element, or between those of differing elements, is the force whose nature I propose to discuss.

It is almost universally admitted that when a mass of matter is heated, the molecules of which it is composed remove farther apart, and the mass expands; on cooling, contraction ensues by the reverse action. It has not been so generally supposed that the atoms in the molecule in like manner approximate and recede. Yet there is reason to believe that the atoms, even in the closest union, are not in absolute contact, and that the cause which prevents that contact is heat. If an absolute zero of heat could be reached, such contact might result, but at present we know of nothing approaching this. We have long known that by the action of heat molecules of compounds separate into their constituent elements; some so readily that they are only stable at exceedingly low temperatures, others can bear higher and higher degrees of heat before yielding, whilst some compounds, and indeed many, can stand the action of the hottest fires attainable by artificial means. This must be so, for, with the exception of the electric arc, our means of producing intense heat depend on the production of compounds such as water and carbonic acid gas. But the new physical science of spectrum analysis enables us to obtain evidence of what is going on in the sun, and we find in that orb elements which, on the earth by our imperfect appliances, we cannot separate from one another by heat, coexisting without combination in that fierce heat, whose intensity is all but unimaginable.

Recent researches by V. Meyer and J. M. Crafts have shown that disassociation can take place between the atoms of a molecule, when that molecule contains atoms of only one element. The researches were made on chlorine, bromine, and iodine, at high temperatures. With regard to chlorine, there is some disagreement as to the results, but bromine and iodine, at temperatures above 800°C, begin to disassociate. The experiment with iodine gave the most accordant results. The vapour of the element, which at 450°C is 8·74 times as heavy as air at the same temperature, at 1400°C is only 5·28 times as heavy. There can be little doubt that if higher temperatures could be applied, further separation would take place, until the density was 4·37, or corresponding to I in the free state, instead of I_2. At the same temperatures carbon dioxide and hydrochloric acid gas showed no sign of decomposition. Spectrum analysis gives evidence which has some weight in the same direction. When the spectrum of a glowing vapour is taken at varying temperatures, it is not found to be the same at them all. This difference is most probably due to some change in the molecules, and as all the evidence tends to show greater simplicity in a molecule as the result of increased heat, the decomposition of the molecule into its constituent atoms is the most probable explanation of the altered spectrum.

The separation by heat of the atoms of the same element in a molecule, is what might naturally have been expected, as the force which holds like atoms together is generally looked upon as comparatively slight, much slighter, indeed, than I believe it to be. The question returns, What is this force? A great name in chemistry, Berzelius, gave the answer, Electricity. In an able review of the electro-chemical theory, unfortunately not printed in our *Transactions*, which one of our vice-presidents, Dr. J. Campbell Brown, once gave, when discussing the composition of ozone, this was fully shown to be incorrect; but as his remarks may have been forgotten, or not heard by some of you, and as this theory, in a modified form, has been brought before the Chemical Society, by that distinguished physicist, Professor Helmholtz, I will endeavour to lay it fairly before you. Berzelius's idea was the simple and fascinating one that the elements might be arranged in a series, of which one extreme was positive electrically, and the other negative, whilst the intervening elements were negative to those above them in the list, and positive to those below. The force of combination was strongest between those most widely separated in the list, and weakest between those which lay near to one another. Reasoning from the experiment in electricity, that if two pith balls are electrified, one positively and the other negatively, they will, when brought near, mutually attract one another, and adhere together so long as the electricity is undischarged, he supposed that the ultimate atoms of matter were in some unexplained way charged with amounts of electricity varying in kind and quantity in different elements, and that what could be seen in the pith balls was the picture of the union of atoms. Thus was explained the unequal stability of compounds, the production of heat attendant on chemical combination, &c. This theory at once fails to account for the formation of molecules of the same element. If two atoms of hydrogen be equally charged with the same kind of electricity, say positive, they ought to repel one another, and thus make the formation of a molecule of hydrogen impossible. Similarly, two atoms of oxygen, both charged equally with negative electricity, should repel one another. Again, one finds a difficulty in understanding how, if in a mass of oxygen each atom is strongly charged with negative electricity, the mass gives no reaction of free electricity, but acts as if it were electrically neutral. The theory is also inconsistent with what we know of substitution. A molecule of marsh gas, CH_4 can have its positive hydrogen replaced by negative chlorine, until tetrachloride of carbon remains, yet the electrical state of the mass remains unchanged so far as external indications go. Helmholtz suggests a view which, so far as I know, is novel, and certainly is what he calls it, "startling." He says, "If we accept the hypothesis, that the elementary substances are composed of atoms, we cannot help concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity." In opposition to Berzelius, he holds that the atoms of any element may be charged or united with either kind of electricity, so that the electrical neutrality of free hydrogen results from one atom of hydrogen charged positively being united with one charged negatively. This gets rid of the difficulty, and accounts for the formation of molecules of the same element. It is now necessary to examine the evidence as to the union of elements being due to the union of opposite electricities.

If hydrochloric acid is decomposed by an electrical current, hydrogen is set free at one pole and chlorine at the other. We can conceive that each element thus becomes charged with electricity. But by the assumption just made, half of the atoms of hydrogen are charged with positive and half with negative electricity. They are all evolved at the negative pole, in consequence of which they should all have the same kind of electricity. But as in a galvanic circuit there is a current of positive electricity passing one way, and an equal current of negative electricity passing in the opposite, it is conceivable that the electric charges may be so communicated to the atoms that an equal number may be charged with each kind. If, however, the union of the electric charges is the cause of the union of the atoms in hydrochloric acid, how does the charging of the atoms with electricity bring about their separation? Also the atoms of hydrogen evolved are charged, one with positive and one with negative electricity, to form a molecule, and the same is the case with the atoms of chlorine in its molecule. Thus the atoms of hydrogen are held together by certain charges of electricity, and form a molecule, and the atoms of chlorine are held together by equal charges to form their molecule, so that the difficulty arises, how there can be any union of hydrogen with chlorine, as the molecule of hydrogen should offer just as much resistance to separation as the molecule of hydrochloric acid. Also, hydrochloric acid can be decomposed by other means than electricity, for the hydrogen can be set free by the action of a metal, and chlorine by passing the gas over heated peroxide of manganese, and the gases thus obtained will combine just as readily, and with as much force, as if they had been separated by electricity. We must therefore suppose that the charge of electricity is inseparable from the atom, and that no influence such as heat or contact with other bodies is able to remove it. The atoms of each element must thus, at their first formation, have been endowed with their electrical charges, half being positively and half negatively charged. But on this assumption we have to account for the disengagement of electricity outside the cell in which the chemical changes take place. It cannot be derived from the atoms, for their electrical charges are inseparable, and if it is answered that it is produced by the transformation of chemical force, that is in the plainest manner to admit that chemical force is not electricity, but only a power capable of generating it as heat is. The difficulties inherent in the electro-chemical theory have been felt by Helmholtz. Thus he says, "I think that the facts leave no doubt that the very mightiest among the chemical forces are of electric origin. The atoms cling to their electric charges, and opposite electric charges cling to each other; but I do not suppose that other molecular forces are excluded working directly from atom to atom. Several of our leading chemists have lately begun to distinguish two classes of compounds, viz., molecular aggregates, and typical compounds, the latter being united by atomic affinities, the former not."

With regard to the last sentence, I think that the leading English chemists hold an exactly contrary opinion; as in the address to the chemical section at the late meeting of the British Association, Professor Williamson said, alluding to this opinion:—"With respect to these views, it may be noticed that the assumption of combination between molecules as due to some other force than that which binds together the constituents of each molecule—in fact, the assumption of molecular combination as an unknown something different from chemical combination—is open to even more grave objections than those which led us to abandon the dualistic system." In a discussion on a paper by Dr. Odling, that chemist and Dr. Roscoe both supported the views of Professor Williamson.

Helmholtz admits the action of other forces than electrical, although their nature is not even suggested; but the main agent is still maintained to be electricity. In my opinion, electricity is not even one of such forces, supposing chemical action to be of complex nature, and I found this opinion mainly on, first, the production of free electricity by chemical action, and, secondly, the known action of electricity on compounds, which, so far as ascertained by experiments, is a decomposing rather than a combining agency.

In considering chemical action, two things must be noted. First, in the union of two elements—say chlorine and hydrogen, to adhere to the simplest possible illustration where single atoms of only two elements unite—there is production of heat, and therefore transformation of force or motion. This is the striking fact in combination, and to it attention is naturally attracted, almost to the exclusion of the other phenomena. Second, when two elements have thus combined, there is the force which keeps them joined together, so that when the molecule of hydrochloric acid is reduced to the state of the surrounding matter, so far as heat and electricity are concerned, the component atoms remain joined by a constantly acting force always the same and of enormous strength. I do not know what the figures are with regard to hydrochloric acid, but in water the force which holds the atoms of one milligramme of water together is estimated as equal to force of gravitation acting between masses, which, together, would be 71,300 billions of times the mass of the water.

Now, just as a mass let fall from a great height strikes the earth, producing heat by its arrested motion, and then lies where it fell, pressing downwards with a constant, unchanging force, under the action of gravitation, so the combining atoms, after in some manner developing heat, remain attached to one another. The analogy is suggestive, and the question arises, Is not chemical force one like gravitation? It is not gravitation, its force is far greater; it is not alike for all kinds of matter, and it only acts at distances almost inconceivably small. The analogies of chemical force with gravitation, however, are so great that it can only be regarded as a specific attractive force, greater in amount as the difference in the properties of the elements is greater. The cause of this attractive force is at present unknown, and I do not pretend to suggest one. The opposing force is heat, and the force of chemical union is the difference between these two forces. Whatever it may be it can hardly be distinguished from the physical force cohesion, as manifested in masses of matter, and the cause of this is equally mysterious. If two surfaces of lead or glass are brought into close approximation, cohesion takes place, and the two masses are so united as to form one whole. Some experiments recently published in the *Journal of the Chemical Society*, for July, 1881, by Dr. Spring, have greatly extended our knowledge of this force. Powdered bismuth, tin, lead, zinc, copper, &c., by a pressure of from 2,000 to 5,000 atmospheres, became solid homogeneous blocks, having the density of the same metals when cast. Similar results were obtained with sulphur and graphite. With regard to the latter substance, this property of cohering under pressure has long been known, and practically employed in making the blocks of graphite from which black lead pencils are made, and the blocks of inferior quality used for domestic purposes. The most remarkable results, however, are those with differing substances mixed together. Thus, copper filings and sulphur at 500 atmospheres pressure chemically combine, and give sulphide of copper; mercuric chloride and copper, at 5,000 atmospheres, gave copper chloride and mercury; iodide of potassium and mercuric chloride, at 2,000 atmospheres, gave mercuric iodide and chloride of potassium. The abstract does not say if in the first instance the combination of copper and sulphur was attended with heat, as when they combine by heating copper in sulphur vapour, or if the combination was due to heat developed by the pressure; and we must wait for further researches in this direction for information which bids fair to be of the utmost importance with relation to the formation of chemical compounds. So far as indicated in the abstract, the effect of pressure seems to be to bring the elements within the range of their attractive force, and chemical force then resolves itself into a form of cohesion. Faraday, in his lectures on "The Forces of Nature," held this view, moreover, for he heads the chapters on chemical force with "Chemical Force—Cohesion."

It may be objected that cohesion takes place between like substances, and chemical force is the strongest between unlikes. But this is not so; cohesion acts powerfully between unlike bodies, and few homogeneous rocks possess the cohesion of heterogeneous granite, whilst in alloys it is impossible to draw a line between simple mixtures of metals and a chemical combination. There is one alloy of zinc and copper, in simple atomic proportion, which possesses definite crystalline form and pure yellow colour, whilst in slightly differing proportions the mass presents the appearance of a simple mixture. Again, iodine and sulphur unite with rise of temperature, and form a crystalline compound, yet alcohol will dissolve out all the iodine. Can this be distinguished from a mixture? And yet, rise of temperature during combination and crystalline form are recognised indications of chemical action. There is indeed an infinite gradation, and no one can say, here cohesion ends and chemical action begins.

This well-known physical force, with regard to the cause of which speculation seems not even to have exercised itself, as I have not met with any theory regarding it, may not seem sufficient to account for the phenomena of chemical action; but when we see the force of cohesion between molecules, as seen in steel, a wire of which one square millimetre in sectional area will bear a weight of 184 lbs., or in the diamond, whose particles are almost indissolubly bound to one another, it is easy to imagine that in the closer contact of atomic cohesion a force may be exerted quite equal to explain all the stability met with in compounds. The difference in properties between a compound and those of the elements of which it is composed may seem too great to be explained by the mere contact of the atoms. But all the properties of matter appear to depend on molecular arrangement; and seeing the total alteration of the properties of phosphorus when transformed from the yellow into the red modification—a change embracing not only physical, but even chemical properties; when colour, hardness, transparency, specific gravity, and even solubility, oxidizability, and action on the animal economy, are all changed, we cease to wonder at the change in properties when a new molecule is formed with two or more differing elements with differing properties.

As with molecular cohesion, so with atomic: heat is the opposing agent. The tenacity of metals diminishes as the temperature rises, until the solid is resolved into a liquid, and the liquid finally into a gas. So with chemical compounds; some can only exist at the lowest temperatures which we can produce, others require but a touch before the bonds of cohesion are destroyed, and the elements go off beyond the bounds of their mutual attraction. As we raise the temperature, more and more chemical compounds are disassociated, some splitting into simpler compounds, but at last separating into their elements, until in heat far surpassing any of man's device, in the solar furnace, where heat beyond the imagination of man struggles with atomic cohesion, compounds such as we know them seem to be impossible, and we seem to behold indications of the decomposition of what we call elements. The decomposition by heat of the molecules of a compound led chemists to foresee that the molecules of elements would fare no better; and we have seen that bromine and iodine, and perhaps chlorine, have been already almost brought into freedom from their mutual bonds. Yet heat often brings about chemical combination, of which it appears to be the antagonist. Hydrogen and chlorine remain side by side without combination, until heat or light causes the dormant force to act. This I look upon as a strong argument in favour of the molecular theory. The atoms in the molecule of hydrogen, and those of chlorine, are held together by a force which, although much weaker than those which unite the atoms of hydrogen when combined with chlorine, are still strong enough to prevent the atoms from coming within the range of their mutual attraction; but heat weakens these bonds, the atoms are removed farther apart, until they are sufficiently free from their former bonds to unite in others more stable, because exerted between diverse elements. Again, mercury and oxygen at ordinary temperatures are without action on one another. By heat the bonds which unite the molecule of oxygen are loosened, the vapourised mercury comes within the range of action, and solid oxide of mercury is formed, in in which the molecular attraction resulting in the formation of a solid body no doubt acts in increasing the stability of the compound. So far, heat acts as an aid to combination, but raise the temperature higher, and the compound ceases to be. Not heat alone, but also that related form of vibration, light, can bring about this loosening of atomic attraction. Hydrogen and chlorine, under the influence of sunlight, or other light possessing what is known as actinism, will combine as if heat had been applied, and it must act, as does heat, by diminishing the attractive force in the molecules of hydrogen and chlorine, so as to enable the atoms of the two elements to enter into the range of their mutual action. This appears to be the rational explanation, for the action of light, like that of heat, is generally antagonistic to the force which we call chemical. In photography, advantage is taken of the decomposing action of light, under which silver salts are reduced to silver, and chlorine, bromine, or iodine. The influence of light in affecting the molecular arrangement of bodies is well shown in a new pigment composed of a mixture of more or less oxidized sulphide of zinc with sulphate of barium. This pigment, when exposed to bright sunlight, becomes dark coloured, but resumes its perfect whiteness in the dark. Here the change is not apparently a chemical one, but due to an alteration in the molecule of one of the constituents. The action of light in vegetation is also a decomposing action, as under its influence carbon dioxide and water lose oxygen.

Electricity must be looked upon as another antagonistic force, for under its influence nearly all soluble compounds are decomposed, whilst it scarcely ever seems to promote chemical action, except where the heat evolved by the electric spark acts like heat derived from other sources, or where some secondary action results from the chemical action of the elements liberated by the decomposing effect of the electricity.

In all these cases we must remember that at the lowest temperature which we can attain, there is still heat acting on the molecule. It is probable that, even in the molecule, this prevents absolute contact, and that the atoms are vibrating under its influence within a certain range, increasing as the temperature rises, or as other vibrating actions are added to those of heat, until the atoms at last swing so far as to escape from the sphere of mutual attraction, and go off to form other molecules.

The effects of chemical force are very striking, heat, light, and electricity being among the accompanying phenomena.

Heat is the most universally manifested effect, no union of elements being unattended by it. Almost all the methods by which heat is artificially produced, either in the animal economy, or for the purpose of warming, depend on chemical force. Our fires owe their heating power to the chemical force which combines the carbon and hydrogen of the fuel with the oxygen of the air, and the intense heat of the electric arc is indirectly the result of the chemical action in the battery, or of the oxidation of the fuel under the boiler of the engine which drives the electro-magnetic engine. Whence is this heat derived, and how can we explain its production? Formerly, when heat was supposed to be a substance, known as caloric, the atoms were thought to hold a quantity of heat latent, and that when the atoms united, the compound, having less capacity for holding heat, the excess became sensible. We now know that this explanation is untrue; heat is only a form of vibration, and when sensible is generally the result of arrested motion. When a bullet strikes an iron target, its motion being suddenly arrested, an equivalent amount of heat is developed, which may suffice to melt the lead. Friction, or impeded motion, can develop heat, as we see in many processes of every-day life, as in the striking of a match. Electricity struggling to pass through a thin platinum wire, meets with resistance, and the wire becomes hot enough to melt even such an infusible metal. Hence, we should naturally look for a similar cause for the heat developed in chemical action, as, for example, when hydrogen, and chlorine, or hydrogen and oxygen unite. There is a common idea that the chemical force is itself transformed into heat. But the force which brings the atoms together is constantly acting with undiminished activity in keeping the atoms together, and as the transmutation of one force into another necessarily implies the cessation of the former one, this explanation must fall to the ground. To what source can the heat, then, be due, except to the arrested motion of the atoms? Flying together with a force varying according to the attractive power they strike, and heat is evolved, greater as the velocity is greater. We thus see in the brilliant light, consequent on the intense heat when iron burns in oxygen, the result of the collision of incalculable atoms of oxygen striking the atoms of iron, just as heat is produced when the blacksmith hammers a bar of cold iron into redness. With such a simple explanation of the heat produced in chemical action, which accords with the production of heat in cases in which we can experimentally demonstrate the cause, it seems almost unnecessary to look for more recondite causes. The amount of heat appears to depend on the force exerted and the stability of the resulting compound. To quote again from Professor Williamson's address, "It has been proved that the heat of combination affords a measure of its force; and we know that in giving off heat particles of matter undergo a diminution of motion. We see, accordingly, that substances capable of exerting great force by their combination, are those which can undergo a great diminution of the velocity of their internal motions, and reciprocally. The force of chemical combination is evidently a function of atomic motion."

As to electricity as evolved in the battery, I do not venture to suggest a cause, profoundly ignorant as we are with respect to a force which may be evolved in such different ways as by the friction of a glass rod, where no chemical action can be supposed, or from the revolution of a coil of covered wire in front of a magnet, where there is just as little. I feel myself utterly unequal to the task of explaining how it is that when zinc is dissolved in dilute sulphuric acid, no perceptible electricity is evolved, whilst if a plate of platinum is put in, electricity is manifested. When the explanation is arrived at, I fancy that it will not be found in any transformation of the force which brings and holds atoms together, but in a result of the motion so produced, akin to that which produces heat.

Amongst the effects ascribed to chemical force of late years, is that in combination with other forces it is competent to explain the mystery of life. It seems now to be considered as the greatest factor in that concourse of powers of which the resultant is vitality. At one time electricity was the favourite agent, and in my opinion there was more to be said for it than for chemical force. Under its influence muscular movements and a faint image of vitality can be given to a recently dead body, but when life is extinct, and chemical force comes into play without check, the whole tendency is to disintegration. Then the complex compounds which exist in the living body come under the influence of external conditions, the unity of the structure is dissolved, bodies more and more simple are formed, until at last nothing remains but some gases, water, and mineral ash. Chemical actions do take place under the direction of life, but they are actions which we can seldom imitate, and in one remarkable instance, the reduction of carbonic acid with evolution of free oxygen, we are unable to repeat the result which a simple vegetable cell presents every moment. There are plenty of chemical actions in the animal and vegetable. The heat of the human body is kept up by the oxidation of carbon and hydrogen, just as the heat of a furnace is. But there is difference even here; this oxidation takes place at a temperature at which out of the body we cannot produce it so completely or in anything like the same time, if indeed, without the intervention of living organisms of low type we can perform it at all. The conversion of starch into sugar is a purely chemical action, but in the laboratory we must use heat and strong acids to perform the operation, whilst the plant does it without the latter, and at a far lower temperature. If we borrow from the plant and use diastase from malt, or from the animal, and employ saliva, we may, indeed, produce the change under the conditions in which the plant or the animal can, but these fermentations are another mystery, and chemistry knows nothing of the manufacture of the ferment. In all these actions, which we can in some sort imitate, chemical force is exerted on formed and dead compounds. It can oxidize and destroy effete matters in the organism, but in the building up of structure, and assimilation of nutriment, we stand in the presence of some directing and controlling power which uses chemical force as a servant, but which can in no way be confounded with it. So man can utilise this force; he can accomplish with it wonders which may not unnaturally excite visionary hopes of dispensing with the aid of nature; but it is the directing mind and hand which bring about these marvels. Chemical force in itself tends to equilibrium and rest. Complex compounds are in a state of unstable equilibrium, and tend to dissolution. They are subject to resolution into more stable, because more simple, compounds, and if this were all, the final result would be death and silence. According to the teaching of modern science, there was a time when the materials of the earth were in a state of intensely heated vapour; as this cooled, simple compounds, as carbonic acid and water, silica, and the oxides of the metals, would be formed. But these are also the most stable and unchangeable compounds, and whence came the tendency to complexity and consequent instability, with life as the crowning point of the edifice. We have not the faintest knowledge of anything in chemistry that can do this. Man, with the inherited wisdom of ages, and every resource in the way of apparatus, and materials manufactured for him in the laboratory of nature, has hitherto not even approached the preparation of what has been called the physicial basis of life. He cannot even find out its true composition, and although the simplest living matter is a complex union of albumenoids, fat, and mineral substances, as shown by analysis, we do not even know whether these may not be nothing but the products into which the living mass resolves itself when it dies. Yet this mass of organic complexity, comprising six or eight elements, or even more, if the mineral constituents are all essential, which, without life, tends to instant dissolution, we are bidden to assume at some unknown time, and under some unknown and, I suppose, unreplaceable conditions, did manage to get formed and forthwith live. It may be so, but chemical force must not be invoked as the agent, for it knows nothing of it. Under the direction of mind, chemical force can work wonders. It has already won triumphs in the manufacture of colouring materials which rival, or even excel, those of nature in brilliancy, and now it is learning to make the finished products of nature. Alizarine, the colouring matter of the madder, and indigo, the product of several different plants, have both been manufactured, and although the latter is still dearer than the natural product, it is presented in a form in which it can be profitably used. It must not be forgotten that every chemical substance of this nature derived from the animal or vegetable kingdom, which has hitherto also been produced artificially, is only an organic substance, in that it was naturally produced by an organism. It was not a living part of that organism, but a product of it, either like urea, a waste material, the final result of the wear of nitrogenous parts of the body, or like conine, an active principal medicinally, but, so far as we know, fulfilling no useful or at least necessary part in the hemlock plant. There is no reason, however, for putting any limit to the result of chemical work in this direction. Every definite chemical substance whose composition can be expressed in a chemical formula, stands forth to be imitated, or rather reproduced, by the art of man. Nor do I think that man is wise who puts any limits as to what may or may not be attempted. It is as rash to say beforehand that a thing cannot be done, as to say that it can. The doing of it is the only proof that the thing is possible, and the only refutation of the charge that it is impossible. But there is little need at present to take down barriers; one has only to read the newspapers to see that those, at least, who know very little of the subject, be it chemistry, electricity, or any other force which has just received a novel application, have the most liberal expectation of the wonders which loom before them, and I fear must feel disappointed that the realisation of their dreams is not forthwith brought about.

In this review of our knowledge of chemical force, I fear that you may feel disappointed at the negative character of the result. I have no new idol to set up for worship, in lieu of the old ones; no new theory of the cause of the rush of atoms and their mutal cohesion to offer. Lucretius might be excused for endowing his atoms with mechanical means of fastening themselves together, such as hooks and spikes, and having set his atoms aimlessly falling through space, accounting for the formation of compounds by the atoms becoming entangled with one another. Those with many hooks thus gave hard and solid compounds, whilst those which were comparatively smooth cohered but slightly, so as to form liquids or gases. In those days theory was rampant; experimental philosophy was comparatively unknown; if things were in some way accounted for, not absolutely absurd, all was well. But there is something from which the human mind revolts in the formation of a universe, with its nice adaptations, and the numberless arrangements for use and beauty in the undirected and fortuitous concourse of atoms. We cannot believe that

> "For blindly, blindly and without design,
> Did these first atoms their first meetings try;
> No ordering thought was there, no will divine
> To guide them; but through infinite time gone by,
> Tossed and tormented, they essayed to join,
> And clashed through the void space tempestuously,
> Until at last that certain whirl began,
> Which slowly formed the earth, and heaven, and man." *

There is mystery here as in all the phenomena of nature. In the simplest chemical reactions there is much that we cannot understand. The old philosopher, Kanada, knew as much as we, and *adrishta,* the Unseen, is still the best name we can give to the chemical force. There is no reason why we should not investigate the secrets of nature, and push our researches into the domains of the unknown. We may be sure that no earnest and sincere work can fail of some reward, and that as the ages roll on more light will illumine recesses of the temple of nature at present dark and impenetrable by human vision. But our attitude should be modest and reverent, and nothing must be received as articles of scientific faith to be accepted under penalty of scientific excommunication. Science means knowledge, not faith, and, short of actual demonstration, the mind must be held free to receive new truth, however opposed to old prepossessions. When we cannot fully explain all that is involved in the formation of a drop of water, I think we ought not to dogmatise on the profound mysteries of life and sensation, and when the action of a single force is fully understood, it will be quite soon enough to speculate on what would be the result of the combination of it with known, or even yet unknown, forces.

* Mallock's, *Lucretius.*

SOME NOTES ON THE LAST MONTHS OF THE LIFE OF MARY QUEEN OF SCOTS, HITHERTO UNPUBLISHED IN ENGLAND.

BY JOSIAH MARPLES.

IT requires no little courage to venture to add another word to the enormous number already written on Mary Queen of Scots. The subject, however, is in itself so full of interest, and all books published bearing the magic name on the title page, are so eagerly sought for, that I trust this small effort to add to the knowledge available for future historians will not be without value.

These notes were partly written two years ago, but my interest in the subject was revived by the reading of a most valuable contribution to its literature, a work which well deserves the hearty reception with which it has met. I allude to *Mary Queen of Scots in Captivity*, by Mr. J. D. Leader, of Sheffield.

The foundations upon which the paper is based are principally to be found in two books, both written at the time of the occurrences they describe, but neither published till recently. The more important one is the Journal of M. Bourgoing, the physician of Mary, who entered her service before A.D. 1580, under date of which year a letter of his is quoted by Mr. Leader,* and who remained in constant and close attendance upon her till her death.

On November 23, 1586, shortly after the announcement to Mary, by Lord Buckhurst, that the Council had sentenced her to death, she wrote to the Pope, Sixtus V, a letter, in which she says, "You shall have a true account of the mode of my final arrest (that of the removal from Chartley to Tixall), and all the proceedings for and against me; that, knowing the truth, the calumnies of the enemies of the Church will not impose upon you; being able to refute them by the publication of the truth. For this purpose I have sent to you this report."*

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* *Mary Queen of Scots in Captivity*, p. 437.

It is easy to understand the reason for this on Mary's part. She was the representative of the Church of Rome in England, and in that capacity had received from Rome signal marks of favour, extending so far, indeed, that to her was given a power, never perhaps bestowed on a woman before or since, that she could administer the Eucharist to herself during the period in which she was by Elizabeth's orders deprived of the services of her priest.†

The report spoken of by Mary in this letter has never yet been found, but there has recently been discovered in the town of Cluny, in France, a manuscript which bears evidence of great antiquity, and which it is believed was originally in the Library of the Benedictines of the Abbey of Cluny prior to its destruction in 1793. Of this abbey Claude of Guise, nephew of Cardinal Lorraine, and therefore cousin of Mary, was abbot from 1575 to 1612. Mary probably arranged for the writing of this book, for under date of the day following that on which she wrote to the Pope, in a letter to the Duke of Guise, she gives some particulars of the proceedings, and says, "You shall hear all that passed."‡ This manuscript bears strong internal evidence that it is the copy of the report in question, made at the time that the original was sent to the Pope. It was hurriedly copied, and is full of grammatical and orthographical blunders, and what are now archaisms, but its personal and pointed allusions, and its close agreement with other published information, no less than its religious tone, which is just what might be expected from so clever a woman as Mary writing to her spiritual father, quite warrant the belief that it is a genuine document. It has recently been published by M. Chantelauze,* *verbatim et literatim*, and it is from his book that I have translated some passages which appear of interest, and which have not been published before. To correct the natural one-sidedness of this account, I have compared it with the letters written by Sir Amias Paulet, Mary's keeper, to his superiors, Elizabeth's secretaries. The duplicate book of these letters has recently been published by Father Morris, the Jesuit historian,† and, though I cannot always agree with his deductions, I have no doubt that his quotations are correct. We are thus, I think, enabled to obtain a fair account of that portion of the final scenes of Mary's life of which I propose to treat.

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* Labanoff, *Lettres, Instructions et Mémoires de Marie Stuart*, &c., tom. vi, 447.

† Quo circa olim tempore persecutionum Christiani omnes quotidie communicabant, ut se roborarent at Martyrium, immo Eucharistiam donum deferebant, illamque mave suis manibus sumebant, uti fecit nuper Maria Stuarta, Scotiae Regina, dum in Anglia captiva detineretur, nec sacerdotem secum habere posset."—*Commentary of Cornelius a Lapide* (Ed. Antwerp, 1639) *on the xxvi chap. S. Matthew*, v. 27.

‡ Hosack's *Mary Queen of Scots*, &c., ii, 439.

I should say that the translations are in all cases my own, and I have endeavoured rather to give a literal translation than a free paraphrase.

Shortly after the death of Mary, an anonymous writer published a small book, entitled *La Morte de la Royne d'Ecosse*, and it has usually been attributed to Bourgoing. That it was not written by him is evident from the fact that its author says he was not present at the last moments of Mary's life, of which we know Bourgoing was a spectator. The author, however, was aware of the existence of Bourgoing's journal, to which he doubtless refers, under the title of "the other discourse," while Bourgoing, having probably inspired the account already written of the death of Mary, gives but a short and meagre description of it in the diary.

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* *Marie Stuart, son procès et son Exécution.* Paris, 1879.

† *The Letter Books of Sir Amias Paulet.* London, 1874.

As my remarks will be more of a personal than a political nature, it will perhaps be desirable to say here what I have to say as to the justice of Mary's death; and I think I shall be able to show that, while it was a political necessity, it was one from which Elizabeth shrank to a far greater extent than is usually credited to her, and I am quite disposed to pronounce her innocent of the final act which has brought upon her so much contumely.

The following lines from Mr. Swinburne's recently-published tragedy, *Mary Stuart*, seem to describe accurately the feelings of Elizabeth:

"I would rather
Stand in God's sight so signed with mine own blood
Than with a sister's—innocent; or indeed
Though guilty—being a sister's—might I choose,
As being a queen I may not surely—no—
I may not choose, you tell me." [*]

On the death of Mary Tudor, Elizabeth had been at once proclaimed Queen. Her rights were derived from her father's will, and the people recognised them so promptly and heartily, that they forgot that the Act of 1st Mary, repealing the Acts of Henry VIII which had declared the King's marriage with Katherine of Arragon null and void,[†] while it declared Mary legitimate in her birth, had the contrary effect upon that of Elizabeth. Hence the partisans of Mary Stuart, who was the next heir, claimed for her the rightful succession, and Mary herself not only claimed it, but adopted the title, and quartered the Arms of England with those of Scotland, which she had from her birth, and of

[*] *Mary Stuart*, p. 66.

[†] Weisener's *Youth of Queen Elizabeth*, i, 168.

France, which had accrued at her marriage with the Dauphin. From this claim really arose that feud, the only end of which was necessarily the death of one or other of the Queens. That Elizabeth, when her rival fell into her power, kept her in an easy and luxurious imprisonment for many years, living in a style superior to anything she could hope for in her own country—for Sheffield Castle, in which she spent fourteen years of her captivity, was a finer palace than any that Scotland could then boast—and bore with all her scheming and plotting, goes far to prove, I think, that she had no strong feeling of antagonism to Mary personally. Speaking of her at an earlier period, Hosack says, "she forgot that Mary Stuart had once worn the Arms and aspired to the Crown of England. She only saw her sister Queen and nearest kinswoman a helpless captive in the hands of men whose characters and aims she knew too well, and she would at any cost obtain her deliverance;* and he says, further, that her ambassador saved Mary's life at that time from the violence of her own subjects. In all previous reigns to be a pretender to the Crown was considered ample reason for a prompt extirpation of the claimant, but Elizabeth and her Ministers bore for eighteen years with the chicanery and duplicity of which Mary's letters give abundant proof, and they would probably have kept Mary in the same light captivity till a natural death had eased them of their burden, had not the growing bitterness between Protestantism and Popery converted her into a martyr, to succour whom was to deserve well of Mother Church, and made her a cynosure of plotting which threatened the peace of the land, and rendered her death a political necessity. Elizabeth's Ministers knew that on the death of their mistress, if she predeceased Mary, their lives would be imperilled, and they felt the importance of terminating this state of affairs by the removal of its head; and hence the issuing of the Commission for the trial of Mary for complicity in Babington's plot, and her sentence to death. Even after this, Elizabeth's respect for her relative, or, perhaps, her feeling of the divinity which should "hedge a king," prevented her from affixing her name to the warrant for Mary's execution for several months, and it is even doubtful whether she ever did sign it at all. The circumstances are too long to be detailed minutely; suffice it to say that Davison, one of the Secretaries of State, says she did sign it, and told him to keep it secret.* Miss Strickland gives an account of the existence of a minute of a Star Chamber investigation in 1606, twenty years after Mary's death, in which it is stated, under deposition of two witnesses, "that the late Thomas Harrison, a private and confidential secretary of the late Sir Francis Walsingham, did voluntarily acknowledge to them that . . . . . he was employed by his said master, Sir Francis Walsingham, to forge Queen Elizabeth's signature to the death warrant of the Queen of Scots, which none of her ministers could ever induce her to sign."†

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* *Mary Queen of Scots and her Accusers*, by John Hosack, i, 356.

There are, however, extant two manuscript accounts of Davison's trial for "misprison and contempt," and from these it would appear that the Queen's Attorney-General, who conducted the prosecution, acknowledged the signature of the warrant by the Queen, and only blamed Davison for issuing it after he had been told expressly to keep it secret, but to have it in readiness so that it could be acted upon when wanted. It was directly after the signature that the correspondence ensued between Davison and Walsingham and Sir Amias Paulet, which leaves an indelible stigma on the names of the former, and, if Davison is to be believed, on that of the Queen also, for the letter undoubtedly presses on Sir Amias the desirability of putting Mary to death in an informal way.* On the refusal of Sir Amias to fall in with this suggestion—a refusal couched in a manly letter, too long to quote—Davison called the Council together, and laid the matter before them. Having the signature they had long wanted, they gave orders to have the warrant acted upon at once, without further reference to the Queen, who appears to have been ignorant of the consummation of the act for some days afterwards. When she received the information, she at once had Davison arrested, and shortly afterwards she wrote to King James of Scotland a letter respecting a treaty, the completion of which had been delayed by the death of his mother, which James euphemistically calls "yone unhappy fact," in which she says, "that so unhappyly to my harts grife was delaied and differd, assuring you on the faith of a Christian and worde of a King, that my hart cannot accuse my conscience of one thoght that might infringe our friendship, or let so good a worke. God the chersar of all harts euer so have misericorde of my soule as innocencye in that mattar deserveth, and no otherwise; wiche invocation wer to dangerous for a gilty conscience." † This statement, made with much more vigour of language than correctness of spelling, seems to have been satisfactory in its effect, for King James expressed his belief in the asseverations of Elizabeth, and she subsequently writes, ‡ "I am greatly satisfied, my dear brother, that I find by your owne graunt that you bilive the trothe of my actions, so manifestly openly proved."

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* *Life of W. Davison*, by Sir Harris Nicholas. London, 1823. p. 232.

† *Cotton MS.*, quoted in *Lives of the Queens of Scotland*, vii, 465.

I must now proceed to the Journal of M. Bourgoing, and I shall select a few passages from it which will give some idea of the difficulty of managing a prisoner at once so bold and so indefatigable in mischief-working as Mary.

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* *Letter Books of Sir Amias Paulet*, p. 359.

† *Letters of Queen Elizabeth and King James VI of Scotland* (Camden Society's Publications), p. 48.

‡ Ibid, p. 50.

The diary opens with the removal of Mary from Chartley to Tixall, concerning which Miss Strickland says, in one of her admirable histories, "the particulars of the journey, the deportment of the Royal prisoner, together with her sayings and doings by the way, would, doubtless, have added a page of no ordinary interest to her personal history."* The story, according to the diary, is as follows:—Mary was at Chartley with a large suite, in charge of Sir Amias Paulet, and on August 11, 1586, she sent her secretary to say she wished to go out after dinner, to which Sir Amias replies that she can do so if she wishes, but if she likes to wait till the morrow, Sir Walter Aston has "promised to give them the pleasure of hunting a stag, which he wished her to kill with her own hands, as she had done some time before." Mary, delighted at the prospect, willingly accepted the invitation, and then made some difficulty because of its being Friday, though she would rather go than sacrifice so good an opportunity, fearing it might not be offered again if she refused it. The Friday, Saturday, Sunday, and Monday not being available, either from the state of the weather or for other reasons, Mary sends word on Tuesday (16th August), and they all start for the hunt, which it would appear from the sequel had been arranged by Sir Amias to get them all out of the house; for Walsingham had sent instructions to that effect, which were faithfully carried out.† The diary proceeds—"Her Majesty, mounted on her horse, rode fully a mile with such speed that, without noticing, we allowed Sir Amias to join some others, who, it is to be supposed, were hidden near. The Queen, having been informed by M. Nau

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* *Lives of the Queens of Scotland, &c.*, vii, 423.

† *Letter Books*, p. 253.

(her secretary) that they were so near, stopped till they came up, wishing to be specially courteous to Sir Amias, and probably to thank him for the unusual entertainment he was giving them. . . After some conversation . . . Sir Amias advanced to the Queen, and said, 'Madame, here is one of the servants of my mistress, the Queen, who has a message to deliver to you from her.'" Mary sat still on her horse, and received from Sir Thomas Gorges the following startling message: "Madame, the Queen, my mistress, thinks it very strange that, contrary to the agreement and pact that you made, you have conspired against her estate; which she never would have believed had she not seen it with her own eyes. As she is aware that some of your attendants are chargeable with and guilty of this offence also, you will not think it ill if she separates them from you." To this Mary made the customary protestations of her innocence, and stated that the Queen, her "good sister and kind friend," had been misinformed. Sir Thomas then remounted, and, after some scuffling on the part of the secretaries, who evidently wished to have a word or two with their mistress, the servants were all separated, disarmed, and taken away to different houses in the neighbourhood, some of them being sent to London for examination. Bourgoing, however, appears to have been left with the Queen, and he continues—"As we commenced to return, surrounded by the troop of new comers, before we had gone more than a mile or two at a great pace, it appeared to me, who kept as close as I could to the Queen, and followed her always, that we were not returning by the road we had come, and I informed her that we were being taken to some other place; upon which Her Majesty called to Sir Amias, who went gently before us. She said, 'We are not going to the house?' He replied, 'No.' Her Majesty said, 'Where are you taking me?' He said, 'Not far;' but Her Majesty told him she should return to his house, and that she would not go anywhere else.

"On this conversation, Her Majesty dismounted, and, much disturbed, was unable either to walk or ride. She sat down first on the ground, and afterwards in the lap of Mrs. Curle, one of the ladies of her bedchamber. She then asked Sir Amias where he was taking her, to which he replied it was to a good place, prettier than his own, and that she could not return to his house. It was labour lost, he added, to remain where she was, or to resist him. On her saying that she would rather die there, he threatened to send for her carriage, and put her into it, and he told one of his people to go for it. He was informed, in reply, that there were no horses for it, as M. Nau had one, and Bastien the other. Meanwhile, those who went before, never looking back, were in a short time so far off as to be out of sight, and we saw them no more. Sir Amias remained with us, with about eight or ten of his people, who were walking behind, and who were much surprised, not knowing what it meant.

"Her Majesty, sitting in this manner, weeping and grieving, said it was a great pity she was taken about thus. She who was a free princess and a foreigner; that it was a treacherous invasion of her rights; that they had given Sir Amias the office of gaoler, because no honest man would undertake such a post. Speaking as haughtily as she could, she said that she was as much a queen as Elizabeth, and of as good a family; that she was only treated thus at the suggestion of those who desired but her ruin; she did not know why these things should be done; she had never done anything that she should be thus driven about; she did not think the Queen of England intended it, but her wicked Council was her enemy; but they must take good care what they were doing, or they would find that this act would be the cause of much bloodshed and death, for foreign kings and princes would resent it some day, and take vengeance for it upon England."

Much more followed to the same effect, and you will therefore not be surprised to learn that the diarist continues:—"Listening to all which, Sir Amias got tired, and asked her to calm herself, and not to vex herself any more; no harm had been done to her; nothing had been done without good reason, and he was powerless to remedy it; the longer she sat there, the more harm she was likely to do herself, and she had better go on. Whereupon it was pointed out by myself and her people that Her Majesty should have patience; she had had many afflictions in her time, which she had borne patiently, and must bear up stoutly and constantly, and with a royal heart support this one. It was of no use for them to counsel force when they were powerless to resist. She was in the hands of her enemies, but we did not think it well for her to remain longer where she was, as she could not stay all night, and the longer she staid, the worse it would be when she did go; not knowing how far she had to go, or where she was being taken, she would be tired, and would be in the road all night, which would give opportunity to her enemies to do her more injury, and execute more readily any evil desires they might have; and that what she did now, she did under constraint."

Mary appears to have been in constant fear that some means would be taken to put her to death in a surreptitious way—a fear which, as I have already shown, was not by any means an unreasonable one. She knew well that her constant scheming would some day meet its just reward, but she had a well-founded opinion that Elizabeth's Council would suffer much before they would venture to bring her to a public scaffold. However, she was finally induced to move, after having bullied Sir Amias, who had also to submit to a great deal of hectoring from her attendants. Sir Amias seemed especially to be touched by Mary calling him a gaoler, for he replied, "that the Queen mistook him; he was not a gaoler, but a gentleman, though a poor one; he was noble, faithful, and good, and he repeated what he had before told her, that gaolers were required only for criminals, and if he were a gaoler, it was because the Queen was guarded as a criminal." After much more conversation, Mary went a little distance off to pray by herself, and though it was supposed to be private, our diarist gives a record of what was undoubtedly a very proper prayer under the circumstances, but he does not say how he obtained a *verbatim* record of it. Eventually she was safely escorted to Tixall, the seat of Sir Walter Aston, in obedience to the command of Elizabeth, in order that she might be separated from her secretaries, and that her desks and papers might be removed for examination; for as Elizabeth said in her letter to Sir Amias, "both the Queen . . . . and her two secretaries, Nau and Curle, had been . . . assisting in a most unprincely and unnatural sort;" in other words, engaged in a plot against her.

Mary remained at Tixall but nine days. Miss Strickland says seventeen,* and Lingard twenty days,† but this diary proves them to have been in error, for she returned to Chartley on the 25th, to find that all her papers and jewels had been taken away. She was received with heartiness by such of her attendants as were left, but she found that even nine days' absence had been productive of important matters in her small Court. Her two secretaries, Nau and Curle, had been taken away prisoners; Mrs. Curle, upon whose lap, sitting on the ground in the park, Mary had sat so long on the day of her removal to Tixall, had been confined of a daughter, and the discovery had been made that Nau had been secretly betrothed to Bess Pierrepoint, a granddaughter of the Countess of Shrewsbury, Mary's first "gaoler." Bess, who had been acting as attendant on the Queen, having, as Mary says,* been "brought up my bedfellow and at board ever sithence she had four years of age, so carefully and virtuously as if she had been my own daughter." As Mary had been arranging another marriage for Bess, and M. Nau had solemnly promised he would never marry, Mary was naturally vexed, but as the guilty couple were imprisoned at different places, she had to nurse her wrath.

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* *Lives of the Queens of Scotland*, &c., vii, 408.

† *History of England*, viii, 213.

That Sir Amias was willing to act as kindly as his orders would permit, is evident from the diary, which says that Mary visited Mrs. Curle frequently up to the 17th September, when she was quite recovered, after which he was under the necessity of forbidding it. He said "he had only permitted the visits from charity and pity for the young lady, who was inexperienced and incapable of managing her affairs, this being her first baby."

A few days afterwards, Sir Amias sent word to Mary to say he and Mr. Bagot wished to see her, as they "had five or six words to say to her." Though she was unwell, and unwilling to see them, they were so persistent that at last they obtained admission to her bed-room, and after, very much to their annoyance, having ordered all the attendants out of the room, permitting our diarist alone to remain near the door, they told her that it had come to the knowledge of the Queen that it was her money "which was doing much harm; that by it she had bribed many persons, both in England and beyond the sea, who had become traitors to their country." They finally required that she should give it all up to them. Mary at once denied that she had any money, or that she had ever bribed anyone. Sir Amias was able, however, to contradict this—their examination during Mary's absence having revealed the state of her coffers—and then she said that "she had never sought any one, but if any one had given her pleasure, or offered her service, she had not wished to be ungrateful, and had recompensed them for their expenses." After a long discussion, and under threats that her chests should be broken open, Mary at last consented, and the casket was unlocked. Mary, who had before said she had no money, now said "she had kept it for a last resource; that when she died it would serve to pay for her funeral and her servants' wages, and to send them back to their own countries after her death." After begging for some of it under several pretexts, even descending so low as to ask for "but ten crowns for play and amusement," she had to see it all go, and her tormentors then went through the same form with respect to the money which was in the possession of Mrs. Curle, the wife of her secretary. At the same time several of her attendants were dismissed, and others, whom it was probably thought might be dangerous, were confined to their rooms.

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* *State Papers*, xviii, No. 74.

"A few days later Sir Amias desired to speak to the Queen, if she would hear him quietly, and not abuse him. Accompanied by Mr. Bagot, they spoke particularly about the troubles of the time; that since England had existed there had never been so great a trouble, nor had there been an enterprise or treason so great as this, nor so horrible; whether she was guilty of, or consenting to it, God knew; but they had taken some who had deposed to important things, and, amongst others, Babington, who, with six men, had undertaken to kill the Queen of England, and proposed to carry off Her Majesty (of Scotland) out of the house; to set fire at night to the farms near the house, that the servants of Sir Amias might go to the assistance of the tenants; and then a barricade of some carts was to be erected to prevent their return, whilst they killed Sir Amias and his companions, and carried away her and some of her attendants, having at two or three miles' distance appointed a number of horses to meet her, and take her where she would be in safety far from there," and so forth. Of course, Mary made the usual protestations that she knew nothing of it, and had never known Babington—a statement which she was shortly after obliged to qualify by saying she had not seen him for some years.

On the 15th September it was proposed to Mary that she should remove to another house belonging to the Queen, and thirty miles nearer to London, and on the 20th she set out for Fotheringay, which she was never to leave alive. The diarist gives some interesting details of the journey, which have not been made public before. Mary never knew from day to day where she was going, her route being kept a strict secret, but each morning, as she started, she was told whether it would be a long or a short journey, and sometimes how many miles. Mary rode in a carriage, with her back to the horses. She chose this position in order "that she might better see those that followed her, whom she thus faced. If she had sat otherwise she would only have been able to see their backs, and she thought if they intended her any harm, she would be able to see the blow coming." Sir Thomas Gorges and Mr. Stallenge were sent by the Government to take precautions that no rescue should be attempted by the way, and the cavalcade, comprising Mary and her attendants, Sir Amias, who was compelled by his infirmities also to take coach, with his wife and family, and a guard of two hundred horsemen, made easy journeys from day to day, staying at Burton on the night of the 21st, at Hill Hall, about seven miles off, on one of the windows of which is a Latin inscription, written with a diamond,* recording the fact of her having been there, on the 22nd, Leicester the 23rd, at the house of Mr. Roger Smith, on the borders of Leicestershire and Rutland, the 24th, and arriving at Fotheringay on Sunday, the 25th September.

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* Miss Strickland. *Op. cit.* 419.

"Around her new prison many curious and painful memories clung. It had been in former times the residence of the Earl of Huntingdon, a title which Mary claimed by right of descent; several of her progenitors and their families had died violent deaths there; Edward Courtenay, afterwards Earl of Devonshire, was confined there for some years; and now Mary was to add her name to the list of unfortunate ones, and close the historic record of crime attached to the Castle."*

At Burton, Sir T. Gorges, who had stated that he had a message from the Queen, was asked to deliver it—Mary saying, when he first mentioned a message, that she hoped his "message was better and more agreeable than the last he had given her." Alas, poor woman! she was to receive but few comfortable messages now, and this one was not calculated to lessen her evident uneasiness. The conversation between Mary and Sir Thomas not having been published before in England, I venture to insert it here. In reply to the request of Mary, Sir Thomas said, "that the Queen of England, his mistress, thought it very strange, and had not expected that the Queen would have undertaken such things as had been discovered against her; that she who was her kinswoman and her equal had put out her hand against her, a sacred Queen. M. Gorges swore that his mistress was never so much astonished at anything, nor so much vexed and troubled as at what had happened. His mistress knew that if she had sent the Queen into Scotland she would not have been safe, for her subjects would do her some harm, while if she had sent her to France, as she had proposed, people would have said she was a fool.

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* Miss Strickland. *Op. cit.* 419.

"Her Majesty replied that, so far as she was concerned, she had never undertaken, nor even thought to undertake, anything against either her person or her state. She was not so deficient in consideration as to wish to put to death, or even to raise her hand against, one anointed as she herself had been. She had always comported herself in her position as she ought to do. She did not know if the Queen, her good sister, had become a Saul, but, as the Queen knew, she was as willing as ever to do as she had hitherto done, to give her notice of anything she knew to her prejudice; for there were many people in her country that had divers intentions and enterprises, but if they (Elizabeth and she) were to take counsel together, they would probably be able to guard against them. To all this Her Majesty had never listened, but had ill-treated and ill-used her with a severity usually shown, not to a prisoner of her quality, or even to a prisoner of war, or taken in some act of hostility, or over whom she had some form of power, but to a private subject, and even worse—as if she had a right of life and death over her—tormenting and afflicting her, taking from her all the comforts of her life, refusing her any communication with her relatives and friends, or any one else—shutting her up in the power of a man, without the will to do anything she might wish—a man who had been as strict as he could be, restricting not only her liberty, but even her eating and drinking, and that of those who were with her. During the time of her captivity the Queen of England had maintained, supported and aided her enemies, and had alienated from her the heart of her son, depriving her of that which she had once possessed, and had even made a treaty with him, separating them, in which treaty she was not included or recognised, but thrown aside and rejected as an abject person, abandoned without hope or comfort, and deprived of all her goods. From that time to the present she had held but small communication with any one, all means having been taken away from her; but if all the Christian Bishops, her relatives, friends and allies, moved by pity and having compassion on her ill-fortune, had agreed to solace and aid her in her misery and captivity, seeing her destitute of all help, she could only throw herself in the arms of their kindness. Knowing nothing of their plans, or of what they had undertaken, or what it was their intention to do, she had not mixed herself with them, and if they had plotted or undertaken anything against the Queen, she was sure that they would admit that she had never countenanced it. The Queen of England well knew that she had warned her to take heed for herself and her Council, as probably foreign kings and princes would enterprise something on her behalf; to which the Queen of England had replied that she was well assured that neither foreign potentates or her own subjects would do anything for her." Sir Thomas could only say to this that he "prayed God it was so," and he afterwards did what he could to comfort her during her journey.

In a day or two, Mary found why she had been removed to a place so much nearer London, for when she complained that there were better rooms in the Castle than had been allotted to her, she was told they were intended for some of the Lords of the Council who were expected shortly, a statement which was confirmed on October 1, when "Sir Amias sent to ask Her Majesty if she was willing to hear a few words from him. This language was usually adopted by him, as she had found by experience, to hide the fact that he had something unpleasant to say." He told her that the Queen had been much surprised at her denial to Sir T. Gorges of any participation in the conspiracy which was under discussion, and that she had determined to send down some of her Lords and Councillors to speak to her on the subject, and now sent to advise her of that fact, in order that she might not be taken at a disadvantage. Sir Amias concluded by a neat suggestion, that she had better at once confess the offences and faults which could be proved against her, and ask pardon of the Queen, adding that as this was his recommendation, he was quite willing to write such reply as she wished. Mary seems to have smiled at the simplicity which could lay so very obvious a trap for her, and preferred to await the coming of the Lords. She said—"She recognised truly that as a sinner she had offended her Maker in many things, and she was willing to ask pardon of Him, but as she was a Sovereign Queen, she did not see that she was responsible to any below for any faults or offences, recognising only God and the Church. She concluded by saying, mockingly, "that she thought he had not travelled far enough, and had taken a great deal of trouble for very little."

On Tuesday, October 11, the Queen's Commissioners arrived in the evening, and on Wednesday, after attending prayers and preaching in the chapel, Sir Walter Mildmay, Chancellor of the Exchequer, with some attendants, waited upon Mary with a letter from the Queen. Miss Strickland says * Mary was in bed, ill, when this was presented to her, but our diarist does not say so, and as he does mention similar matters on other occasions, I think there is reason to think Miss Strickland was mistaken. The Queen's letter appears to have been of a very imperious nature, for the diary says it had no superscription of title, nor "Madame," nor "My Sister," nor anything else, and was signed at the end simply "Elizabeth," without "Your Sister." It was sealed with the Great Seal, and at the foot the address was, "To the Scottish." The letter simply stated that as Mary had refused to reply to the questions put to her, it had appeared right for the Queen to send down a Special Commission to

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* *Op. cit.* 424.

hear and decide upon the matter; as Mary was a resident in the kingdom and under the protection of Elizabeth, so she was subject also to the laws. Mary appears to have given a dignified answer to all this, which was duly written out for the Queen's edification, and it is strong proof of the authenticity of the diary that the answer of Mary, as given in it, is almost word for word the same as is given in the State papers, under the title of "The Scottish Queen's first answers," allowing, of course, for the fact that one is in French and the other in English. Mary, for a day or two, with many words, tried to prove that she was not responsible to an English Court; and she certainly seems to have made out a good case for herself, which, however, was of no avail, as it was intended that she should be tried, whether she was willing or not; so finally "Her Majesty replied that she cared little about it. God would inspire her and direct her to do according to His will and justice, and she thought she would consent to it."* The next morning (Oct. 14), Mary sent for the Commissioners, and made an address to them, which seems in its sum to amount to this—that she had not attempted the life of the Queen, but she did not deny her correspondence with foreign princes. As the address has not been published before, and as it contains in a few words Mary's defence to the charges brought against her, I translate it thus:—"Gentlemen, considering the position that I hold—a born queen, a foreigner, a near relative of my good sister the Queen—I cannot but object to your assemblage and your procedure, as I do not hold myself subject either to your laws or your Queen. I must decline to reply to your charges, and so prejudice my high estate and that of other kings and similar persons. As I have always held my honour in esteem, and will not spare my life in its defence, I am ready, rather than prejudice other princes and my son, to die or endure such other penalties as you may pronounce upon me, if it is only thus that the Queen, my good sister, who has so bad an opinion of me, and who has been misinformed in that I have attempted any plot against her person, can be satisfied of my innocence and of the good will which I have borne and still bear towards her, as I have frequently shown in the offers which I have made, and in my conduct. In order, then, that it may not be considered that I refuse to reply because I am guilty, and lest it may be thought that ambition may have induced me to commit any act, blameable or unworthy of my sacred person, I offer to reply to you upon this point only—Upon the life of the Queen, of which I swear and protest that I am innocent; but on no other matter whatever, as to intelligence, friendship or correspondence which I may have had with foreign princes. In making protest of this, I demand, also, a written copy of the act of accusation." *

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* *Marie Stuart*, &c., p. 511.

It is unnecessary for me to follow the course of the trial; suffice it to say that it is difficult to see how any jury or court could do otherwise than bring in a verdict of guilty on the evidence laid before them. Mary denied everything that was charged against her, and to any proofs which were brought forward of her complicity in the conspiracy of Babington, she only replied by denials, and by a refusal to acknowledge the right of any to question her. There are, however, one or two unpublished words of hers that it may be desirable to read. For instance, at the close of the second day's sitting, the diary says the proceedings had been "conducted in such a manner that the poor Princess said to us, in returning to her chamber, she remembered the Passion of Jesus Christ, and, without making any comparison, it appeared to her that they were doing in her case as the Jews did to Christ, when they cried, 'Away with Him; crucify

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* *Marie Stuart*, &c., p. 512.

Him,' and she was sure there were none in the company who had any pity for her, or who would say what they thought."

Another speech of hers, of which the English accounts of the trial give no particulars, reads as follows in the diary :—

"Her Majesty remonstrated on the wrong which the Queen had done her in keeping her prisoner, who had come on parole and a princess to a country where she had been, for nearly eighteen years, annoyed by treatment so bad that the meanest person should not have been subjected to it, though she had given no occasion for it, and there was still less right; by such treatment she had lost her health and the use of her limbs, as they could see; she could neither walk nor use her arms; she was ill, and almost always confined to her bed; old before her time, and consumed with misery, having lost the little spirit God had given her; unable to remember that which she had seen and read that could aid her at the present time, and the knowledge of matters that had enabled her to conduct and direct the necessary business which appertained to the state to which God had called her, and of which she had been traitorously and unjustly deprived by those who had detained her, and prevented her from claiming her rights. Not content with this, her enemies, by their ill-will, were trying to ruin her by proceeding in this trial by methods not customary in her own country, and not known in this kingdom before the reign of the present Queen, and further than that, by judges sanctioned only by illegal authority, from whom she appealed to the Omnipotent God, to His Church, and to all Christian princes, and to the estates of the realm duly and legitimately assembled. She was ready and willing to sustain and defend her honour, and prove herself innocent of the suspected wrongs, if they would give her public opportunity in the presence of some princes or foreign judges; and would show to such judges that she had done nothing against her mother the Church, or against kings, sovereign princes, or her son. Specially with respect to the right which the English have long claimed over the predecessors of her Majesty, Kings of Scotland, which right she utterly denied, and, as a woman or person of courage, would never admit or strengthen by any act of hers. . . . She would be able to show them she was not ambitious, and that she had never undertaken anything against the Queen, from ambition or wish to reign; that she was past all that, and for herself wished only to pass the remainder of her life in peace, rest and tranquillity of spirit. Her age and weakness rendered her unwilling to take the responsibility of reigning, and gave her no opportunity of wishing for or aspiring to any government or public charge, being ill and diseased in her body, and having only probably but two or three years to live in this world; and considering the pain and wretchedness which surrounded her to-day in her endeavour to obtain justice and the recognition of her rights, in this age so evil disposed and so full of all wickedness and trouble, which seemed to fill all parts of the earth."

Poor woman! her own kingdom rejected her; her French friends did not want her, and now the asylum in which had she been disposed she might have lived peaceably and died happily, was to be refused her. The long course of restlessness, duplicity and chicanery of which her letters give ample proof, had produced its natural result, and it was necessary for the peace of the realm that she should die.

One of the Scottish historians says:—"Had Queen Mary abandoned the world and its politics, the opportunity might have been given for her abiding in England in a retirement becoming a fallen monarch. From the moment, however, when she set foot on English soil she was so beset by dreams of superseding her rival, that she could not conceal them from those around." *

The next day, the diary says, Mary made a noble speech, which, however, covers only the same ground as the last, and which it is needless to recapitulate. It would, indeed, be very desirable that a complete translation of the diary should be made, as it contains many speeches of Mary, in her defence, which are either ignored or summarised in the English reports, and a knowledge of which is necessary to complete the history of the trial. One charge against her does not appear to have been reported at all—that of her having incited Pius V to issue a bull of excommunication against Elizabeth. Mary denied this, and said she had no power in the matter, and that the Pope issued his bulls when he thought fit; to which the Chancellor replied that they did not care for the Pope or anyone like him. The question of Jesuits and their doings gave rise to considerable discussion which is not mentioned in the English reports, but which the diarist details in full.

The trial completed, the Commission, whose powers extended no further than to hear what Mary had to say, adjourned their sittings till the 29th October, and went back to London to make their report, and to assist in the Session of Parliament then about to commence.

Sir Amias appears, according to our diarist, from this time to have treated Mary rather more courteously than had been his wont. The change of locality and the reduction of her staff had probably rendered it impossible for Mary to continue her correspondence with the outside world, and the non-delivery of her letters saved Sir Amias from the frequent scoldings he had received for his want of care, and in consequence Mary recovered her health and spirits so much that Bourgoing says he "never saw her so joyous or so well during the last

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* Burton's *History of Scotland*, 2nd Ed., v. 256.

seven years, giving her mind only to recreation, specially to uttering her opinion upon matters written in the Chronicles of England,* from which she seems to have gathered subjects of conversation with Sir Amias, who says, under date of Oct. 24, in his letter to Walsingham,† "She added that the histories made mention that this realm was used to blood. I answered that if she would peruse the Chronicles of Scotland, France, Spain and Italy, she would find that this realm was far behind any other Christian nation in shedding of blood, although the same was often very necessary where dangerous offences did arise. She was not willing to wade farther in this matter, and indeed it was easy to see she had no meaning in this speech to reach her own cause, but did utter it by way of discourse after her wonted manner."

On All-Saints' Day, after dinner, Paulet had a conversation with Mary, in the course of which, "talking courteously, she said ‡ she had no occasion to be uneasy or troubled. She knew well in her conscience what she had done, and she had replied to all said against her. God and she knew that she had never attempted, or consented to any attempt, to kill or murder any one, and her conscience was perfectly clear and free from any connivance with anything of the sort, and, being innocent, she had rather reason to rejoice than to fear or to be troubled, having confidence in God, the protector of good and innocent people. Few people in her position had gone through so much trouble as she had. At the pleasure of God, she had suffered, and she had been preserved, God having always succoured and helped her. She feared not now, but if it was His will, she was ready to endure death. She had been born in troublous times; the Queen, her mother, had brought her up with much trouble;

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* *Marie Stuart*, &c., p. 539.

† *Letter Books of Sir Amias Paulet*, p.301.

‡ *Marie Stuart*, &c., p. 541.

she had then gone to France, where, however, she did not long enjoy the happiness that she had obtained, as her husband died, and she returned to her birth-place, where she found further trouble in a country which had been disturbed ever since it was a country, and it would profit very little if she was further afflicted.

"Sir Amias said that it was a great comfort to a person to have a clear and easy conscience—God knew how far hers was so—but a heavy and deceitful conscience was a very bad thing, and that she had better confess and repent before God and the world, if she was guilty, as certainly seemed to him to be distinct and evident, the matter having been so clearly elucidated before her that even she had been unable to deny it." In reply to this home-thrust, Mary made a statement too long for quotation, in which she stated that it was for her religion she was to be punished, and expressed her readiness to die for it. "Sir Amias," says our diarist, "replied that it was not a question of her religion—that had never been mentioned—it was a question of murder, rebellion and invasion, and that, being guilty, she should not deny it; and that as to her, if she had committed so horrible a crime, neither she, nor her party in the country, nor even all the Catholics in the kingdom, if they consented to it, could be otherwise than worthy of punishment."

This conversation is continued at some length. Mary, with true feminine perseverance, wishing to have the last word, and insisting with her last word that her religion was her crime, and that anything else had only been the excuse for bringing her to the position in which she now found herself; and she added a quaint remark that it did not matter whether it was a "white mantle or a mantle of white, it was all one—they had made up their minds before the trial." She concluded by repeating what she had several times said, that England was the most sanguinary of all nations, for they were in the habit from all time of putting to death or deposing their kings according to their will. Sir Amias replied it was the nation least given to that, to which Mary said their chronicles were full of them.*

Lord Buckhurst and Mr. Beale were shortly sent to convey to Mary a message from Queen Elizabeth that the Houses of Parliament having condemned her to death, she would be reluctantly compelled to give her consent to it, as she had been told that there would be no safety for her life or peace for her country till the sentence had been carried out. On the following day, Paulet, with perhaps too little ceremony and consideration for his prisoner, ordered the removal of the canopy which up to this time had been one of the insignia of Mary's royal birth, and sat down in her presence with his hat on to show that her degradation was complete, a step for which he received a reprimand from head quarters, and apologised.† It is curious that the diarist makes no mention of this fact. Day followed day and week succeeded to week, and still Elizabeth was unwilling to sign the warrant which would condemn to a violent death her cousin and heir apparent; and it was during this time, when Mary lay under sentence of death, that Paulet and Sir Drew Drury, who had been named his coadjutor, received the letter already referred to, in which they were told by Walsingham and Davison, "We find by speech lately uttered by Her Majesty that she doth note in you both a lack of that care and zeal of her service that she looked for at your hands, in that you have not in this time of yourselves (without other provocation) found out some way to shorten the life of that Queen, considering the great peril she is subject into hourly so long as the said Queen shall live. . . And therefore she taketh it most unkindly towards her, that men professing that love towards her that you do, should in any kind of sort, for lack of the discharge of your duties, cast the burthen upon her, knowing as you do her indisposition to shed blood, especially of one of that sex and quality, and so near to her in blood, as the said Queen is."* The Secretaries are very anxious that this letter should be destroyed, or as they call it "made heretics of," but Paulet said he would prefer to return it to them, and then they would be sure it was destroyed.

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* *Marie Stuart*, &c., p. 545.

† *Letter Books*, p. 317.

On February 1, the date of the despatch of the letter from Davison and Walshingham last read, the warrant for Mary's death appears to have been signed by Elizabeth. For six weeks Davison had the warrant in his hands unsigned, but the day after the refusal of Paulet and Drury to put Mary to death without warrant, the document was, as already explained, laid before the Council, and the Earls of Shrewsbury and Kent were sent down to carry it into effect.

The diary records their arrival thus:—

"On Tuesday, 7/17 February, several people arrived, amongst whom we believe was the Sheriff, who dined with Sir Amias; after dinner came the Earl of Kent, and last of all the Earl of Shrewsbury. At their arrival we were all alarmed and in great fear, having fancied that for the three days previous many events had occurred pointing to a speedy and evil end to Her Majesty, and fearing the blow would assuredly fall.* They sent to ask to speak to Her Majesty, who said she was in bed, but if it was anything important she would receive them when she had time to dress. Having received a reply to the effect that it was important,

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* *Letter Books*, p. 359.

* *Marie Stuart*, &c., p. 571.

Her Majesty prepared to receive them in her room, sitting in her chair at the foot of the bed. When the said Earls were come in with Mr. Beale, Sir A. Paulet and Sir Drew Drury, the Earl of Shrewsbury stood up bareheaded, together with the others, who never uncovered all the time they spoke to her, saying that the Queen of England had sent him to appear before her, in her own name, as well as that of her Parliament, to let her know that, after having tried her, as she knew, honourably, for the matters which were charged against her, she had been found guilty and condemned. He was now commanded by the Queen to read the sentence, which the Earl of Kent, Mr. Beale and himself were required to put into execution.

"The said Beale then commenced to read it, written on parchment, and with the Great Seal of England in yellow wax hanging from it. It called Her Majesty Marié Stuart, daughter of James V, otherwise called the Queen of Scots, Dowager of France."

The remainder of this conversation has been published, being a part of the anonymous paper, *La Morte de la Royne d'Ecosse*, published by Jebb. In fact, the remainder of the diary is condensed from this paper, but in such a way as to justify the belief already expressed that Bourgoing inspired the account referred to, which was first published in 1589.

It will be unnecessary, as it would be painful, to read the account of the final scene, which has already been so fully described by all writers on the subject, and on which I can throw no new light. During the night before her death Mary made her will; and as a curious termination to her long and persistent asseverations that she had never imagined or countenanced anything evil against her dear sister and cousin, Queen Elizabeth, she contrived to leave a sting behind her, which troubled England for years, for she left to Philip of

Spain all her right, title and interest in the Kingdoms of England and Scotland, the enforcement of which bequest was one ostensible object of the attempted invasion of England by Philip—

> "When that great fleet invincible against her bore in vain,
> The richest spoils of Mexico, the stoutest hearts of Spain." *

I venture, in the interests of Historical Science, to protest against the gross misuse of great names by the romancists and poets. The latest instance, and the one which exhibits in a most marked degree the fault of which I complain, is to be found in Mr. Swinburne's tragedy of *Mary Stuart*, recently published.

The poem is the third and last of a series, entitled respectively, *Chastelard*, *Bothwell*, and *Mary Stuart*, and the second scene of the first act is principally a conversation between Mary Stuart and Mary Beaton, and the whole play and its catastrophe rest upon a supposed wrong to the latter in connection with the death of Chastelard, which wrong she has for twenty years sought to revenge; this revenge is at last brought about by her sending to Elizabeth a letter, supposed to have been written some years previously by Mary Stuart, in which she animadverted strongly upon Elizabeth's reputed impropriety of conduct. The letter, written in a time of annoyance and vexation, had not been sent to Elizabeth, but retained by Mary Beaton, who had been instructed by Mary Stuart to destroy it; and the revenge was accomplished by its being sent anonymously to Elizabeth, at a time when the latter was being importuned by her ministers to sign Mary's death warrant. Mr. Swinburne bears just testimony to her indisposition to condemn to the scaffold a queen related to herself; but the receipt of this letter so disturbs her equanimity that she signs the warrant, which she hands to Davison with the words—

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* *The Armada.* Macaulay.

> "Take this hence,
> And let me see no word, nor hear of her,
> Till the sun see not such a soul alive."

The last act, which describes the incident of Mary's death, also exhibits Mary Beaton, who has been the close attendant for many years, still the bosom companion of Mary, whom she attends to the scaffold, when she sees accomplished the vengeance which must have been rankling in her breast for more than twenty years without having been once suspected. Now this poem, I venture to say, will be largely read and often quoted, and I think I am quite within bounds when I say that for every one who knows the historic facts there will be a hundred who will prefer to take their history from the play, and who will believe that at any rate there must be some strong foundation for it, and in forty or fifty years hence any one endeavouring to point out the truth in the matter will be told, as I was told a few months ago when endeavouring to put in a truthful light some facts connected with Amy Robsart, that "Scott would be found to be too much" for me; so, in years to come, Swinburne will be too much for history. In fact, the *Pall Mall Gazette* says that "as a poetic rendering of history, *Mary Stuart* is probably the foremost of our time."

As a matter of fact, Mary Beaton never came to England at all after Mary Stuart came, and hence never could have attended her, and certainly never could have worked out the imaginary scheme of revenge with which she is credited; and the only *fact* in the whole play is the letter, which it is admitted was written by Mary, but which it is believed never was seen by Elizabeth, having been intercepted by Cecil, in whose family papers it yet exists. The play never seems for one moment to throw blame upon an attendant who could act as confidant and close companion for twenty years, bearing all that time an unsatisfied scheme of revenge in her heart; but it does much justice to the characters of Elizabeth and Mary. Her condemnation of the conspirators, and her message of defiance to the French King, show Elizabeth to the best advantage; while her anxiety to save Mary's life, if possible, is done justice to, and Mary's better qualities are those upon which the poet lingers most. Probably the truest estimate of her character with which I have met is that put into the mouth of Sir Drew Drury. (Act iv., sc. ii.)

"She was born right royal; full of sins
It may be, and by circumstance of choice
Dyed and defaced with bloody stains and black,
Unmerciful, unfaithful, but of heart
So fiery high, so swift of spirit and clear,
In extreme danger and pain so lifted up,
So of all violent things inviolable,
So large of courage, so superb of soul,
So sheathed with iron mind invincible,
And arms unbreached of fireproof constancy—
By shame not shaken, fear or force or death,
Change or all confluence of calamities—
And so at her worst need beloved, and still,
Naked of help and honour when she seemed,
As other women would be, and of hope
Stripped, still so of herself adorable
By minds not always all ignobly mad,
Nor all made poisonous with false grain of faith,
She shall be a world's wonder to all time,
A deadly glory watched of marvelling men
Not without praise, nor without noble tears,
And if without what she would never have
Who had it never, pity—yet from none
Quite without reverence and some kind of love
For that which was so royal."

THE LIFE-SAVING SERVICE OF THE UNITED STATES OF AMERICA.

By CHARLES H. BELOE, M. Inst. C.E.

Most of the Members of this Society are no doubt to some extent familiar with the provision made in this country for the preservation of life from drowning on our coasts by the Royal National Life Boat Institution, the Rocket Apparatus furnished by the Board of Trade, and the Life Brigades of our North-east coast, but I think very few of you have had the opportunity of making yourselves acquainted with the extent and nature of the Life-Saving Service of the United States of America; and I hope that any organization having for its object the preservation of the lives of those who go down to the sea in ships must have an interest for all Englishmen, and especially for the inhabitants of a great seaport like Liverpool. I will therefore endeavour to give you an idea of what is being done in this direction by our cousins on the other side of the Atlantic.

In the first place, I must draw your attention to the great difference, both in extent and character, which exists between the coast of our Islands and that of the United States.

The length of our British coast is comparatively small, and in nearly every case where there are many passing ships, and consequently great risk of shipwrecks taking place, it is more or less populated; whereas the American coast, on the contrary, is of great extent, having a seaboard of ten thousand miles, and in many places is almost uninhabited. It passes through nearly every variety of climate, and is therefore subject to all vicissitudes of weather, from the rigors of winter storms and tempests in the north, to the hurricanes and tornadoes of the tropics.

The nature of the coast also varies considerably, and differs materially from that of this country.

On the Atlantic, from the north-eastern boundary to Boston Bay, it is jagged and indented by glacial fiords, capes, reefs, and islands extending far out to sea, and although these are a source of danger, they also furnish many excellent places of shelter.

The coast of Massachusetts is also dangerous, especially in the neighbourhood of Cape Cod, projecting as it does forty miles into the ocean, with its outer shores surrounded by tiers of shifting bars, at various distances from the land; nearly every point of this side of the Cape has been the scene of shipwreck.

The conformation of the coast from the eastern extremity of Long Island to Cape Fear has a remarkable and uniform feature. Along nearly the whole of this stretch of six hundred miles, except where interrupted by the New York, Delaware and Chesapeake Bays, the coast line is a strip of sand beach, from a quarter of a mile to five miles wide, intersected and broken into islands at varying distances by narrow inlets and separated from the mainland in most instances by long narrow bays. These beaches are constantly shifting, and at times advance considerably into the sea; the inlets also frequently change their position, and but few of them are navigable. Outside this cordon of beaches are numerous dangerous shoals, and all along it are bars of sand.

Of this dangerous section of the Atlantic seaboard, the Long Island and the New Jersey coasts, lying as they do on each side of New York, present a terrible record of disaster, and the beaches are strewn with the skeletons of wrecked vessels.

The neighbourhood of Cape Hatteras is also peculiarly dangerous. Extending further out to sea than any other land on the Atlantic coast, with the exception of Cape Cod, the Gulf Stream passes within twenty miles of its extremity, and the mingling of the warm currents of air which follow the Gulf Stream, with the colder currents sweeping along the shore, produce violent commotions and storms.

From this point to Florida the coast line is little liable to disaster, lying as it does in a mild latitude and distant from much important sea-going traffic.

The outer coast of Florida borders a waste and desolate region for nearly five hundred miles, and is approached by a large number of vessels.

At certain seasons it is visited by heavy gales and tornadoes, by which vessels are thrown upon its inhospitable shores, and the unfortunate beings who have escaped from the perils of the sea, find themselves exposed on land to the probability of death by starvation and thirst.

In the Gulf of Mexico the water is shoal for a great distance out, and although vessels frequently ground, life is not often in peril, although considerable loss to property is incurred.

The Pacific coast is regular, bold and unbroken, containing but few harbours. The winds prevail with almost the regularity of the monsoons, the weather is easily prognosticated, and navigation cannot be considered hazardous.

The Lakes of America must also be taken into consideration, containing as they do about eighty thousand square miles, with a coast line on the United States shores nearly two thousand five-hundred miles in length. They are frequented by an immense amount of commerce, and are swept by sudden and violent storms.

The Government of the United States, like most Governments, was exceedingly slow to recognize the necessity of making some provision for the preservation of life on their coasts, and the earliest efforts in this direction were made by the Massachusetts Humane Society, formed in 1786 and incorporated in 1791. It commenced operations by the erection of huts for the shelter of persons escaping from wrecked vessels upon the exposed and desolate coast of Massachusetts. It has erected new ones and discontinued old ones from time to time as circumstances have required up to the present day, and now maintains eight of these huts and sixty-six stations, supplied with boats, rafts, mortars and other apparatus.

The Government has at various times granted pecuniary aid to this Society.

In 1848 the Government first gave its attention to the method of aiding stranded vessels by the establishment of stations, furnished with the means of effecting communication between such vessels and the shore. Under the direction of Captain Ottinger, eight stations were erected on the coast of New Jersey, and supplied each with a metal surf-boat, a metal life-car, mortars, rockets, &c.

By 1854 one hundred and thirty-seven life-boats were stationed on the coast, including those belonging to the Humane Society of Massachusetts and the Life-Saving Benevolent Association of New York, a similar body founded in 1849.

Some of the Government Lifeboats were placed in charge of Lighthouse Keepers and officers of Customs, who generally took good care of them, but in a majority of instances they were placed in care of town corporations, which became forgetful of them, or of short-lived benevolent societies, which, expiring, left them to decay, or of private citizens, who became unmindful of their responsibility. The occasion of a wreck would bring one into use, and it would then be put in order, and kept ready for an emergency, but the Government does not appear to have exercised any supervision over the boats, many of which were lost sight of, others were found in a decaying state, and some were appropriated to private use. One was used by the inhabitants as a public makeshift, being carted about from place to place, and made to do duty as a trough for mixing mortar and a tub for scalding hogs.

In 1853-54 great loss of life took place through the inefficiency of the lifeboat service, and in the latter year an Act of Congress was passed authorizing the appointment of a superintendent for each of the coasts, and a keeper for each station, also the establishment of many additional lifeboat stations; but these were not erected. No provision was made for the employment of crews, the stations being dependent upon volunteers, often difficult to obtain on the sparsely populated coast.

The service remained in this unsatisfactory condition until 1871, when many fatal disasters occurred within the limits of the operations of the service, and the circumstances showed beyond dispute that the loss of life was largely due to the want of proper attention to duty on the part of the officials, and the inefficient condition of the boats and apparatus; this was confirmed by a report from an officer instructed to inspect the stations, and a thorough reorganization of the service was determined upon.

The removal of incapable and inefficient officers, and the substitution of suitable men; the repair of the stations, and their equipments; the employment of selected crews at nearly all the stations, and the promulgation of a series of instructions, specifically setting forth the duties required of officers and men, were the first steps taken in order that the service might be placed upon as efficient a footing as possible for the approaching winter's work. Measures were also taken for the establishment of as many additional stations as were necessary to bring them within about three miles of each other, where natural obstacles did not prevent, with a view of enabling each to summon, by process of signalling, its neighbours to its assistance when needed.

The stations of Life-Saving Service are divided into three classes. The first class are intended for exposed localities, destitute of inhabitants, where crews to render assistance in rescuing the shipwrecked cannot readily be collected, and where the means of sheltering and succouring the latter are not at hand, and also for flat beaches with outlying bars.

These stations are about 42 feet in length, and 18 feet in width, with a lower and upper storey, each divided into two rooms. One of the rooms below is appropriated to the proper arrangement of the boats, wagon, surf-car and other heavy apparatus; and the other is plainly furnished as a mess-room for the crew.

One of the rooms above is intended for the storage of the lighter portion of the apparatus, and the other is provided with a number of cot beds and suitable bedding.

This class of stations is established upon a portion of the Atlantic coast, and upon the Lake and Pacific coasts at a few points where such protection seems requisite.

The second class of stations is intended for localities where aid can readily be procured, such as the vicinity of large ports, where accidents frequently occur through the crowded state of the channels. At most of these places facilities exist of launching the self-righting and self-bailing lifeboat on the English system, therefore these stations are merely boathouses to contain the lifeboats, and a few other articles, the boats being manned by volunteer crews, to whom compensation is paid for services rendered upon each occasion of shipwreck, in the same manner that the English lifeboat crews are remunerated.

The third class of stations is designed exclusively for the coast of Florida, where the requirements for relief are widely different from those of any other portion of the seaboard, the usual apparatus of the other classes of stations being for the most part unnecessary; shelter and the means of subsistence being the most essential requisites.

The stations are constructed of sufficient capacity to succour twenty-five persons; they are stored with provisions sufficient to sustain that number for ten days, during the months in which hurricanes prevail, and are placed under the care of responsible keepers, who reside in them. Each station is provided with a light surf-boat, supplied with oars and sails.

The average estimated cost of each class of stations is for a—

First class station and equipments, or a complete life-saving station	$5,303 or	£1,093
Second class or life-boat station	4,790 „	987
Third class or house of refuge	2,995 „	617

The average total cost of an English lifeboat station is £1,000.

Considering the high price of labour in America, the life-saving stations in that country appear to be economically constructed.

As to the boats which are used on the Atlantic coast, it is exceedingly difficult for anyone accustomed to our English lifeboats to believe that such fragile looking shells can be effective as a means of saving life in the heavy seas which prevail on that coast. But the records of the service show that thousands of lives have been saved by the use of them, and that accidents to the men using them are extremely rare.

On many of the sparsely settled and sandy wastes which characterize the coast of Cape Cod and nearly the whole of the coast from Long Island to Cape Hatteras, the use of any self-righting and self-bailing lifeboat yet devised would be impracticable for want of means of transportation, even if the shoalness of the water did not in nearly every instance preclude the possibility of launching it.

The model adopted is that of the cedar surf-boat in general use by the wreckers of the coast of New Jersey, with such improvements as could be suggested by an old and experienced surfman; but these boats do not possess any of the qualities which are in England considered so essential to a lifeboat, the only merits they possess being those of lightness (some weighing only 800 lbs.) and handiness; but the men are accustomed to the boats, and there is a great difference of opinion as to whether self-righting and self-bailing boats are after all preferable to the best surf-boats. During a severe gale at one of the Lake stations provided with an excellent lifeboat, the crew preferred to use one of the improved surf-boats, with which they rescued the crews of two vessels.

In all parts of the world the greatest difference of opinion exists among boatmen as to the *best* boat, and this is proved by the great variety in the types of boats used in different localities. The United States are no exception to this rule, and setting aside the fact that there are local circumstances which call for boats specially adapted to contend with them, an inquirer would find, on beaches essentially the same, among surfmen of the longest experience and soundest judgment, the most radical differences of opinion in regard to the ideal surf-boat.

As stated in the reports of the service :—" One man will " insist that it should be broad in the stern ; on another beach " it is demanded that the stern shall be sharp. Great sheer " is the insistance of this expert, less sheer the obstinate " rejoinder of a second.

" In one opinion cork fenders are indispensable ; another " surfman will strip them off the boat if sent him. The winds " do not blow in greater variety than is found in the views of " these practical adepts in the art of surfing."

In order to decide upon what improvements could be effected in the equipment of the stations, two Boards of Officers have been appointed, one to consider all propositions relating to boats, rafts, life-cars, transporting carriages, hauling lines, and similar contrivances. The other Board has charge of whatever pertains to wreck ordnance and its appurtenances.

Up to the present time the first-mentioned Board has not recommended any radical change in the construction of the surf-boats already in use, being of opinion that the peculiarities of the Atlantic coast render a light surf-boat preferable to the heavier lifeboat, but a self-righting and self-bailing lifeboat invented by Captain Dobbins has been purchased by the department and placed at one of the Lake stations. This boat is but little heavier than an ordinary surf-boat, and on one occasion, when proceeding to a wreck, capsized in the breakers, but immediately righted again with the men in their places and proceeded to the wreck, from which all the crew were safely brought ashore. Another self-righting boat has been built by Superintendent Richardson, which weighs about 1 ton 12 cwt., and has a draught of water of 18 inches when loaded. The smallest English lifeboat of the Royal National Lifeboat Institution weighs about 2 tons, and draws 22 inches of water. For some stations the reduction in weight is not so important, but the reduction in draught of water is generally of the greatest consequence.

This boat is built of cedar and white oak, framed and planked in the usual style of ordinary boats, and is therefore cheaper and less difficult to build and repair than the English boat, which is constructed of mahogany, and double planked diagonally, but it cannot be so strong and durable as the latter.

The end air cases are flat instead of convex, as in the English boats, which is a rather doubtful alteration. The water is delivered from the deck through large scuppers at the side, arranged with shutters to prevent the rushing back of water into the boat. These are considered preferable to the English delivery pipes, as the latter are liable to become choked with ice.

It is said that the management of the surf-boats by the surfmen is superbly skilful, and they believe that the little craft in their hands will safely ride through any sea in which a lifeboat can live.

The lifeboat is necessarily of such a form as to preclude the quick manœuvering the surf-boat admits of, and the surfmen have such confidence in their own dexterity, to which the light boat renders an almost magical obedience, that they would prefer to rely upon it rather than be bothered in a dangerous sea with what they would consider the clumsy work compelled by the build of the heavier and perhaps more seaworthy vessel.

The weight of opinion, however, among those who have studied the subject in America, as in England, is in favour of the self-righting and self-bailing lifeboat, and the officers of the Life-Saving Service are convinced that such a boat capable of being used at all their stations will eventually be devised, and, after the surfmen have become acquainted with it, it will supersede the surf-boat, and be used where otherwise the mortar apparatus would be resorted to.

Up to the present time a very large proportion of the rescues effected by the Life-Saving Department have been accomplished by establishing communication between the shore and the wreck, by means of a line thrown from the former.

An enormous number of experiments have been made with various patterns of rockets, mortars, and guns for effecting this object, and the systems in use in European countries reported upon.

The result has been the adoption of Lieutenant Lyle's life-saving gun at all the stations, and a recommendation to adopt the Lyle Emery grapple shot.

The guns are made of bronze, composed of 90 per cent. of copper and 10 per cent. of tin; they are cast in iron chills, and have a bore of 2½ inches, and are 24¼ inches long over all.

The shot generally used with these guns is cylindrical, with an ogival head, and a shank in the base furnished with an eye to which the line is attached. The length of the shot is 9¼ inches, and of the shank 6½ inches, and its weight 17 lbs. The shot is inserted in the gun with its point towards the breach and the shank projecting beyond the muzzle.

After a great many trials, the department has decided upon braided linen as the best material of which to make the shot lines, owing to its lightness, strength, and other advantages.

The line is carefully coiled in a box specially prepared to receive it, called a "faking box," and when the gun is fired the shot soon turns over in its flight, owing to the resistance caused by the line and the superior weight of the head of the shot.

The improvements effected by Lieut. Lyle in these guns is very remarkable, as his small gun has a range slightly exceeding that of the mortar in use at the time he was instructed to investigate the matter, while the weight of his gun is only one-third of that of the service mortar, and his large gun has a range exceeding that of the largest mortar in use, while the weight is only 202 lbs. as compared with 568 lbs.

The ranges obtained with the Lyle gun are as great as will admit of the use of the breeches-buoy or life-car with success; in fact, great difficulties are frequently encountered by the life-saving crews, owing to the hawser and lines getting entangled; and the violent motions of the wreck often cause the lines to snap, or else the wreck drives up the beach; and difficulty is experienced in keeping the lines tight, and frequently in winter they become clogged with ice.

The Lyle Emery grapple shot weighs 18 lbs., and consists of a cylindrical body with an ogival head, to the base of which are attached four arms or flukes working on hinges, which, when closed, do not project beyond the body of the shot. There is also a fixed shank, with an eye at its extremity to which the line is made fast.

The projectile is inserted in the gun point first, with the flukes closed, and the line tied to the eye of the shank. In this position the base of the shot is towards the muzzle of the gun, the flukes partially enter the bore, while the shank extends beyond the muzzle. In firing, the projectile describes the first part of this trajectory base foremost, the strain upon the shank being towards the rear; the flukes are kept closed, but as soon as the projectile reverses its position, as it must do in the course of its flight, the tension on the line draws out the shank to the full extent of its play in the base of the shot, thus spreading the flukes.

A stop prevents the flukes from closing, but this can be effected by hand when the shot is recovered.

The use of this shot is either to throw a line over a stranded vessel, or in the event of the crew sending a barrel or raft afloat with a line attached, in the hope of effecting a communication with the shore, and from some cause, such as a current carrying the raft on a course parallel with the beach, the grapple shot is fired over the line paid out from the stranded vessel, so as to pass between the vessel and the buoy; then, by hauling the attached shot-line, the flukes grapple the ship's line, and enable the life-saving crew on shore to secure the line from the vessel.

A range of 325 yards has been obtained with this shot with a charge of six ounces of powder, which is remarkably good; but the average range may be taken as 200 yards with a charge of two ounces of powder.

Great advantages would be derived if vessels in this country, as well as in America, were compelled to carry a gun, shot and line, as in the majority of cases it is far easier for those on board the ship to throw a shot on the shore with a line attached to it, than it is for the life-saving crews on shore to throw a shot over the ship; in the first place, a ship is a small object to hit, and the line may fall in some inaccessible place, where the exhausted and, perhaps, half-frozen crew cannot reach it, whereas those on the ship have the whole shore to aim at.

Most wrecks occur with an on-shore gale; consequently the shot fired from the ship would generally fly with the wind; whereas the shot fired from shore has to carry a heavy line out against the gale, thus diminishing its range, and if the wind is not directly on the shore, it blows the shot and line so far out of their course as to make the task of hitting the vessel very difficult.

The only outlay involved by this suggestion is that of the shot, as the gun could be used for ordinary signals, and the special line and faking-box might be dispensed with, though their use should be preferred.

The labour of hauling the mortar-car through the soft sand of the beaches, in teeth of a blinding gale, being so severe, every effort is made to reduce the weight as much as possible. The articles carried in the car are—the gun and its bed, hauling lines, hawser, sand anchor, crotch, and life-car, making a total weight of 1,700 lbs., or over 15 cwt.

By substituting the breeches-buoy for the life-car, the weight is reduced to 1,500 lbs., or nearly 13½ cwt.; but even then this load has to be dragged by seven men, making a weight of 214 lbs. per man. It will therefore be apparent how important it is that the weight of the apparatus should be reduced as far as is consistent with efficiency.

With this object, the Government instructed Lieut. Lyle to investigate the rocket systems adopted in other countries, and accordingly he reported upon the Russian, German, and English (Boxer's) Rockets, also Hooper's, an English invention, but not, I believe, adopted by the English Government.

Lieut. Lyle is evidently not in favour of rockets, as with them, he says, "One never knows what may happen or where they will go to when fired."

In the opinion of the Board there are grave objections to the use of rockets for life-saving purposes, such as their liability to deterioration when stored for any length of time, the uncertainty of their flight, and other matters. The Board was of opinion that the apparatus now in use in the service is, in addition to its undoubted greater economy, superior in efficiency to any system of rockets that has been tried, but recommend the adoption of the English wreck lights for illuminating the beach when a wreck occurs.

Having thrown the line over the wreck, the shipwrecked crew proceed, as in England, to haul on the line, to which is attached the tallyboard, with instructions how to proceed printed in different languages, also the tail-block and whip. The tail-block being made fast on board the ship, the surfmen haul on the whip and convey the hawser to the wreck; one end being made fast on board, the rope is carried over the crotch or tripod, and hauled taut by means of tackles secured to the sand-anchor; the hawser thus forms a sort of suspension bridge between the wreck and the shore. Various methods have been used for conveying persons from the wreck along the hawser, and until recently the department adopted the life-car, which is in effect a small covered boat, capable of holding from two to four persons, and suspended from the hawser by rings; the life-car has the advantage not possessed by any other contrivance of bringing women, children, and sick people to shore in a dry condition, and without risk, and on some occasions bullion and other valuable property has been saved by its use. Two hundred and one persons were saved by the car at the wreck of the Ayrshire, on the New Jersey coast. But it has its disadvantages; one being the inconvenient means its narrow hatchway affords in the commotion of the sea for receiving those who are to enter it; but the most serious drawback to its use is its excessive weight of 221 lbs., as compared with the 21 lbs. of the breeches-buoy; consequently the use of the life-car has been reserved for cases when large numbers of persons have to be saved, and when the crews of several stations have collected at the wreck, the breeches-buoy being taken first to the scene of action for the sake of speed.

The life-car is the invention of Captain Ottinger, who received $10,000 from the Government for his invention.

Life-rafts have also been tried as a means of saving life; they consist of cylinders with a platform between them, and possess the advantage of being able to accommodate a considerable number of persons at one time, that they are easy to get on board, and can be used as boats under oars. On the other hand, they may be capsized and those on them thrown into the surf, and are not so well adapted as the life-car for the conveyance of feeble persons. In 1879 the report of the department states, that after considerable enquiry it has been found that however valuable they may be as a means of escape on shipboard, the superiority claimed for them in effecting rescues from the shore has not yet been established.

The life-saving dress invented by Captain Merryman, of the Life-Saving Department, and made familiar to most people by the exploits of Paul Boyton, is one of the authorised equipments of a life-saving station, and on several occasions has been used with great advantage.

Sometimes the surfmen, after firing a line over a wreck, put on these dresses and haul themselves along the line to the vessel, the crew of which are perhaps too terrified or too ignorant to work the apparatus; on other occasions, by the aid of these dresses, the men can venture into the surf and rescue people from drowning who would otherwise have been carried out to sea by the fearful undertow.

In cold weather a surfman, clad in this dress, will sometimes proceed from a station to the mainland, his route being through creeks and marshes which could not be safely traversed in an ordinary costume.

The admirable storm signal system of the Signal Service of the United States is connected with a number of the life-saving stations, and great benefit has resulted therefrom; telephones are also being rapidly introduced where practicable.

Having now described the principal items of the apparatus used by the service, I must say something of the crews which man the stations.

Like all other appointments in the United States, the position of a surfman has been the subject of political partisanship, and vigorous efforts are being made to remove this reproach from the service. A bill was introduced into Congress for the improvement of the service in 1879, and was not carried, but it is hoped that soon it will become law. The last section of the bill embodies the important provision "that the appointment and employment of all officers and crews of the Life-Saving Service shall be made without reference to their political or party affiliations, and solely with reference to their fitness."

The reports of the service constantly reiterate the necessity of selecting its agents strictly upon grounds of professional qualification; in fact, so much is said upon this subject, that one cannot help feeling that a large number of men now in the employ do not possess the requisite qualifications, but have been appointed for political reasons.

The office of General Superintendent is filled by Mr. Sumner J. Kimball, who was appointed in 1871, and to whom the present organisation of the service is due; and it is to the admirable reports issued by this gentleman, which may be found in the Free Library, that I am indebted for the information I have been able to bring before you.

The post of Inspector and Superintendent of Construction of Life-Saving Stations is occupied by Captain J. H. Merryman, of the United States Revenue Marine, who has for long rendered noble service in the Life-Saving Department, is the inventor of the dress already alluded to, and the author of an admirable article in *Scribner's Monthly* for January, 1880, the graphic illustrations to which will convey a better idea of the services rendered by the station crews than can be done by words alone.

The total number of stations is one hundred and seventy-nine, one hundred and thirty-nine being on the Atlantic coast, thirty-four on the Lakes, and six on the Pacific coast.

There are twelve districts on the Atlantic, three on the Lakes, and one on the Pacific. Each district is under the immediate charge of a superintendent, who must reside in it. He nominates the keepers, makes requisitions for stores, and pays the crews their wages.

To each district is assigned an Assistant Inspector, who is also the commanding officer of the revenue cruiser.

All officers of the service are invested with the powers of Customs officers, which enable them to protect the interests of the Government in preventing smuggling.

As a check against the employment of incompetent men as keepers or surfmen, it has been found advisable to hold an annual examination of the stations by a Board, composed of an Inspector of the Service, who, in addition to his inquiries into the qualifications and behaviour of the men, inspects the condition of the stations and their appointments; secondly, of a Medical Officer (a surgeon of the Marine Hospital Service), who subjects each person to a thorough test of his physical soundness, and also gives the usual instructions in the method of resuscitating the apparently drowned ; to these is added a practical surfman, qualified by long experience and ripe judgment to decide upon the abilities of the keepers and crews as they are put through the manœuvres of handling their boats in the surf before him, or conducting operations with the wreck guns and life-car gear.

The crew of a station consists of a keeper and six men, which is simply adequate to the manning of the six oars of the boat and the oar of the steersman.

The following description of the duties of the surfmen is taken from Captain Merryman's article already mentioned:—

"Each day has its drill and exercise, and much spare time is devoted to keeping the building and apparatus in repair ; at night the duties become severe, and often perilous. The interval from sunset to sunrise is divided into three watches. At the beginning of each watch two men set out from the station on patrol duty, and follow their beats to the right and left respectively until they meet the patrol men from the adjacent stations, with whom they exchange certain tokens as proof to the keepers in the morning of the faithful performance of their duty. The meeting and exchange of tokens is required of course only upon continuous beaches where the stations average a distance of three to five miles apart ; at isolated stations the limits of the patrol are fixed by specific boundaries. The watching of the beach is of cardinal importance, and neglect of this duty is punished by banishment from the service and prohibition of future employment.

"The beach guardians are no idle promenaders; a march of four or five miles through the soft sea sand is a task at any time—what is it in the fury of a winter storm? The prevalent strong winds which must be encountered in one direction or the other of the beat drive before them rain, snow, hail and sleet, or oftener sharp sand, which cuts the face, until, smarting with pain, the patrol man turns and walks backwards for relief. Such is the force of this natural sand blast, that it soon dulls the glass of the patrol lanterns, and at some of the more exposed stations has made ground glass of the window panes. In a snowstorm the ocean beach is the wildest of pathless deserts, and even by daylight, shut out from prominent landmarks, the foam of the breaking surf alone serves to guide the patrol man on his way. Leaving it, he would wander helplessly among the sand-dunes that crown the beach. When the darkness of night is added, and his lantern, if not extinguished by the gale, but feebly lights his path through the slush of snow and sand, he strays and stumbles into pitfalls and quicksands, to recover his way and accomplish his journey only through his lifelong acquaintance with every foot of the ground. Sometimes failing in this, benumbed with cold and bewildered by his mishaps, he is found by his comrades in the snow, insensible, or perhaps dead."

Another danger, to which not only the patrol men but the stations themselves are exposed on the Atlantic coast, is the tidal wave raised by a tornado, which sometimes overturns a station, and the waters flowing far inland surround the patrol men, who have to be rescued by means of boats.

The life of an American patrol man must be one calling for great courage and endurance, and from the manner in which the crews of the Life-Saving Service carry out their arduous task, there can be no doubt that they are worthy rivals of English lifeboat men, whose noble services are so familiar to us all, and whose courage and endurance were so severely tried when the Ramsgate men lay in their boat for fourteen hours trying to find the wreck of the Liverpool ship "Indian Chief," on January 6th, 1881, when the cold was so intense, and to the severity of which they were exposed in an open boat for twenty-six hours.

The last report of the Life-Saving Service contains several important recommendations, and it is to be hoped that they will be carried into effect; one of these is that a seventh man should be added to each crew.

This additional man would be of the greatest advantage, by remaining on the beach to assist in launching and beaching the boat; he would lighten the patrol duty, giving each man one night's uninterrupted rest in the week. He could also take charge of the station during the absence of the crew, and have hot food ready for them on their return, which would be a great boon to the men and to any persons they may have rescued.

Another recommendation is the supply of one or more horses to the stations, to assist in hauling the boats or mortar cars, whereby the crews would arrive at the scene of the wreck comparatively fresh, instead of, as at present, in an exhausted state from the labour of hauling.

These two recommendations have been partially carried into effect, but only by restricting expenditure on matters of scarcely less importance.

The stations are not manned during the summer months; the time for employing and discharging the crews varies, but the longest period of service is from September 1st to April 30th inclusive—a period of eight months.

The following are the statistics of the services rendered by the department during the year 1880 :—

Three hundred disasters to vessels occurred within the scope of the operations of the service.

There were one thousand nine hundred and eighty-nine persons on board these vessels, of whom one thousand nine hundred and eighty were saved, nine only being lost; four hundred and forty-nine shipwrecked persons were succoured at the stations, receiving in the aggregate one thousand two hundred and two days' relief. The total number of vessels lost was sixty-seven.

The year 1880 is marked by a higher record of casualties than any previous year, and these services were not rendered without loss of life to the service, and the whole of one crew of six men perished by the capsizing of their boat, the keeper alone escaping, although the men wore the admirable life-belts introduced by our Lifeboat Institution. This sad event is another proof of the advantage of the self-righting boat, as these men would in all probability have been saved if their boat had been of that description, for they were all kept afloat by their jackets, but perished from cold during their long immersion.

The only department of the Life-Saving Service of which I have now to speak is that of the awards of medals.

It is a somewhat significant fact that in a Republican country like the United States, where titles and decorations are not conferred by the Government for public services rendered, no matter how meritorious those services may have been, that the medals awarded for exertions in saving human life should be of unusual magnificence and value. The medals are of the first and second class, the former being of gold and the latter of silver.

Many of you may remember the wreck of the American ship "Ellen Southard" off the mouth of the Mersey, on Sept. 25th, 1875.

On that occasion the lifeboats belonging to the Mersey Docks and Harbour Board, and the New Brighton lifeboat of the Royal National Lifeboat Institution, were both engaged;

the former unfortunately capsized, and three of the lifeboat men, the pilot, and eight of the shipwrecked crew were drowned, the remainder being rescued by the New Brighton boat. The services of our Liverpool lifeboat men were recognised by the United States Government through the Life-Saving Service in the most handsome manner, and the survivors of the crews of the two lifeboats, twenty-seven in number, were each presented with a gold medal of the first class, together with a letter of thanks from the Government of the United States. $200 were also awarded by that Government for the families of each of the three lifeboat men who lost their lives on that occasion.

The total expenditure of the Life-Saving Service for the year 1880 was $435,962 or about £89,889, and in the previous year $363,674 or £74,984.

In order to be able to form some comparison of the work done in the United States and in our own country for the preservation of life on the coast, I may state that the expenditure by the Royal National Lifeboat Institution during 1880 was £37,577, for which amount 271 lifeboats and stations were maintained. £1,800 voted for the support of the widows and families of lifeboat men who had perished in the discharge of their duty, and numerous rewards given for saving life by shore-boats and other means. 577 lives were saved by the lifeboats, 120 by shore-boats, &c., for which awards were granted, and 430 by the rocket apparatus worked by the Coastguard and the Rocket Volunteer Brigades, the cost of which service I have not been able to ascertain.

In conclusion, I only hope that this, I fear, very dry recapitulation of facts and figures may have been the means of impressing upon your minds that we are not the only people who endeavour to rescue those who are exposed to the perils of the deep, and to encourage you to support that noble institution which in England supplies the place of a Government Life-Saving Service.

I do not wish to discuss the question whether work of this description is better undertaken by a Government department or by a charitable institution. Perhaps the truth is that, like the self-righting lifeboat and the surf-boat, each is specially adapted for particular localities, and in an enormous country like the United States, it would perhaps be impossible for a charitable organisation, depending for its support upon the populous cities, to organise and maintain a series of stations over so large an extent of coast and one so thinly populated. At the same time it behoves us, residents in a small country like this, to remember that, densely populated as it is, there are scores of localities where lifeboats are stationed dependent entirely for their support upon the surplus subscriptions from large cities like Liverpool, and where the local subscriptions are entirely inadequate to support the station; and I trust that Liverpool will always be found one of the largest contributors to that institution which in England supplies the place of a Government Life-Saving Service.

ON THE VELOCITIES OF GASES.

By ALBERT J. MOTT, F.G.S.

My object is to suggest a physical method by which the maximum molecular velocities of gases may be determined within certain limits.

Assuming the truth of the Kinetic theory, a gas is composed of molecules not resting in contact, but in constant and rapid motion in straight lines in all directions. There are other motions also, rotatory and vibratory, but it is the motion of direct translation in straight lines till something is encountered that is here considered.

The cause of this motion is heat communicated to the gas, or more correctly this motion itself is the sensible heat of the gas. In solids the molecules are held together by forces which prevent their heat motion from separating them. In gases these forces are absent or have been overcome, and the molecules, no longer held together by them, move independently under the influence of heat. Every gas has received this motion from some definite source, and the motion would be lost if it were not continually renewed. In a glass jar, for example, full of air, the gaseous molecules constantly beating against the sides of the jar would soon exhaust their motion; that is, the air would become colder and colder till it fell to the temperature at which it would cease to be gaseous, and would take a liquid or solid form. But the jar renews the motion as fast as it is wasted; the glass itself is heated, that is, also in motion, and though the motion in this case is vibratory and the glass molecules do not leave each other, they give back to the gaseous molecules as great an impulse as they receive from them, the motion of the glass itself being maintained by other sources of heat, which we may finally trace back to the rays of the sun or the temperature of the earth.

But if a gas is not inclosed in anything, so that its molecules meet with no resistance except from their mutual encounters, the effect of their motion is to spread them farther and farther apart, the gas thus expanding without limit unless some force acts upon it from without. And as it expands, and the distance between its molecules increases, their encounters become less and less frequent, till at last some of them, and finally all of them, tend to fly off along independent paths through space.

We never meet with empty space, however, and gases as we know them are always inclosed. Any given portion of air, for example, has the earth beneath it and other portions of air above and around it, and its moving molecules meet in every direction with something from which they receive fresh impulse and by which they are driven back.

In the atmosphere, however, while the earth below it makes a solid wall, the air above any portion of it makes a wall that can be more or less penetrated. This wall also becomes thinner and less substantial as we go higher, and at some upper limit there is no longer anything to meet and confine such of the molecules as are moving upwards. What then will happen to them? They will ascend to a certain height above the earth, and then fall back; the height to which they are carried being determined by the velocity with which they start and its relation to the force of gravity.

The actual velocity with which gaseous molecules move is determined in this way:

The normal pressure of the atmosphere downwards, on a square inch, at the earth's surface, is equal to the pressure of a dead weight of not quite 15 lbs. The air itself is not, in fact, a dead weight, but its pressure is equal to this, and we measure it by this standard.

Take a tube one square inch in section, closed at the bottom and fitted with a piston at the top, and filled with air. The piston does not move down under the pressure of the atmosphere. Remove that pressure by creating a vacuum above the piston, and put upon it an iron weight of about 15 lbs. instead. The piston remains as before. The column of air under it resists the pressure of this weight, and the resisting force is of course equal to that which causes the pressure.

A weight of 15 lbs. is a certain mass acted on by gravity. Gravity at this latitude is a force which, if it acts unresisted for one second on any mass which is free to move, will cause it to move at the end of that time with a velocity of 32·2 feet in a second downwards.

This is the force resisted by the air under the piston. The resistance is caused by the impact of the moving molecules, of which the air consists, striking upon the under side of the piston. What, then, must the velocity be with which they move ?

If a weight of 15 lbs. moved upwards with a velocity of 32·2 feet in a second, it would exactly balance the weight of 15 lbs. moving downwards with the same speed. And a smaller weight will balance it also if its speed is increased sufficiently. The force exerted by a moving body, if it moves with different velocities, is in proportion to the squares of those velocities. Ten times the speed gives a hundred times the force. A hundred times the speed gives ten thousand times the force.

Suppose the tube of air, one square inch in section, to be 32 feet long. The weight of the air in it is 120 grains. The weight upon the piston is in round numbers 100,000 grains.

The motion of the 120 grains resists the pressure of the 100,000. But the molecules of air are moving in all directions, and not only in an upward direction against the piston, and the final result of their combined motions is that the air acts as if one-third of its molecules moved directly upwards, the others not affecting the piston.* One-third of the molecules weigh 40 grains. We have to learn, therefore, with what velocity 40 grains of matter must move to exert a force equal to that of 100,000 grains moving at the rate of 32 feet per second, at the end of a second. 100,000 is to 40 as 2,500 is to 1. We therefore take the weight upon the piston as 2,500, and the weight of the effective molecules under it as *one*.

Now, the column of air is 32 feet long. If it moved at the rate of 32 feet in a second, the whole of it would have struck the piston at the end of a second, and if the weights were equal, the force in that time exerted against the under side of the piston would have been exactly equal to the force then acquired by the weight above it. But the weight above is 2,500 times the weight below, and the latter, therefore, must move with a velocity which will increase its force 2,500 times. That is, it must move 50 times as fast; for the square of 50 is 2,500. 50 times 32 feet in a second is 1,600 feet in a second; which is about the mean velocity of the molecules of air. It would be the exact velocity at a given temperature if exact figures had been used instead of round numbers. The difference is not great.

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* This is a deduction from Clerk Maxwell's reasoning. (*Theory of Heat*, p. 294.) The whole pressure exerted in all directions by any portion of gas is the resultant of all the forces due to the velocities of all its molecules. These forces may be resolved in any three directions at right angles to each other. As the pressure of the gas is known to be equal in all directions, these three components are equal, and the force exerted in any one *direction* is therefore one-third of the total force. And in a straight tube closed by a piston, all the forces exerted by all the molecules within the tube in one direction parallel with the sides of the tube are exerted upon the piston. Or, suppose a cubical box, with six equal sides therefore, with three equal balls in it, moving independently at the same speed along three lines at right angles to each other; one up and down; one backwards and forwards; one from side to side. Each side of the box will be struck at equal intervals by one of the balls. If we can measure the effect of the blows, and if we know the weight of the three balls together, we can tell at once the weight of each, and the velocity with which they move. The three balls represent the whole of the molecules of a gas taken together, moving in such a manner that the force exerted by them on each of the sides of the box is constantly the same. And to make it so, each side must be continually struck by *one* of the balls when the whole number is *three*.

These proportions, it will be seen, hold good whatever the length of the tube may be. Suppose it to be one foot instead of 32 feet. The weight of the resisting column of air is only $\frac{1}{32}$nd of the former weight. But it will all strike the piston in $\frac{1}{32}$nd of the former time, and gravity in that time, therefore, will only have exerted $\frac{1}{32}$nd of its former force upon the weight above the piston.

Now, in observations of the moon, no evidence of an atmosphere there has been discovered, either directly or by its effect upon light. The total absence of any gaseous covering is not positively demonstrated, for it might exist without being detected if it were extremely thin and shallow and permanently transparent. But there are no good grounds for supposing that perfect transparency could be maintained. Any atmosphere on the moon's surface would be subject to very rapid movement, from the great difference in temperature between the light and dark sides of the satellite. If there were any water, there would certainly be clouds, and if there were none, it is probable that finely powdered dust would be abundant, and would be often carried into the air.

Assuming that there is in fact no atmosphere on the moon, an inquiry into the cause of this condition is at once suggested. If planetary bodies with cool surfaces have atmospheres round them, these must consist of the gases or vapours that are permanent at low temperatures, and the number is not large. But some of them are so abundant on the earth, and there are so many proofs of their existence in other bodies, that their presence may naturally be expected anywhere. There are distinct evidences of atmospheres in the principal bodies of the solar system, and that the moon should be without one requires explanation.

The Kinetic theory of gases gives a probable reason for this exceptional state. A gas being a substance in which the individual molecules are moving rapidly in all directions, the atmosphere of any of the bodies in space is a layer of gas so situated that there is nothing to prevent its molecules from flying off and leaving it, except the force of gravity. This force depends on the planetary mass, and in a small body like the moon, it is so feeble that anything leaving its surface with a velocity of about 7,500 feet in a second will never return.*

Now, 7,500 feet per second is the *mean* velocity of the molecules of hydrogen at a temperature of about 300° F., and is therefore a speed within the reach of gaseous molecules generally. If it is actually reached by the molecules of gases at the moon's surface, they cannot remain there.

The speed of gaseous molecules as deduced from their pressure is only the average speed, and this is doubtless less than the highest.

As the molecules of a gas are all equal in size and weight, we might infer that when in any definite portion of it they are subject to the same conditions, the velocities, which are the result of those conditions, would be uniform. But if this

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* The velocity required is the square root of 2RG, where R is the moon's radius, and G the acceleration due to gravity at her surface.

The moon's diameter is 2,153 miles. Taking the moon's mass and radius as unity, and the earth's mass and radius as 88 and 3·68—

$$\frac{3{\cdot}68^2}{88} \times 32{\cdot}2 = 4{\cdot}9 \text{ feet} = \text{G at moon's surface.}$$

$$\sqrt{2\text{RG}} = \sqrt{2{,}153 \text{ miles} \times 4{\cdot}9 \text{ feet}} = 7{,}460 \text{ feet.}$$

were the case at any instant, this uniformity of speed would be immediately destroyed by their mutual encounters. When two moving bodies come into collision, the speed of both of them is necessarily changed. If they are equal, and move with equal speed in opposite directions when they meet, there is an instant when both of them stop, absolutely, and if we suppose their elasticity to be perfect, so that they rebound with the same velocity as before, the force of elasticity, like all other forces, requires an interval of time to produce its final effect, and during that interval all the velocities between the final one and actual rest are passed through. And molecules moving in all directions must meet each other at all angles, and during the periods of all their velocities, and therefore with all varieties of effect on each other's momentary motions, the general result being that there is a speed which is never exceeded, but that at every instant there are molecules moving at every intermediate speed between this and the state of rest. We assume, therefore, that some molecules are necessarily moving faster than the average in all gaseous masses, and the question, What is the greatest speed attained by any of them? becomes one of considerable interest.

It is the greatest speed, and not the average speed, that will determine whether an atmosphere of gas can remain on the surface of an attracting body; for if only a small proportion of the gaseous molecules move fast enough to fly away, and if this condition is permanent, the whole will gradually drain off, and the departure of the whole atmosphere is only a question of time.

I propose to consider what inference concerning this maximum velocity might be drawn from the hypothesis that the moon possesses no atmosphere, *because* the molecular velocity of gases at her surface is too great to allow them to remain there.

There are good grounds for the hypothesis itself. The moon's appearance suggests the action of volcanic and explosive forces as among its causes, and these forces, as known to us, require the agency of gaseous matter. If such a surface as the moon presents could be produced merely by the cooling of a melted mass, which is not probable, the heat of fusion would certainly liberate many substances in a gaseous form, and that all of these should condense into solids is again unlikely. And the analogy of the earth, to which she is so near, and of other bodies in the solar system, leads us to expect that gases would be found on the moon if they could be retained there.

If Mr. G. H. Darwin's theory of the effect of tidal action is accepted, and if we suppose, in consequence, that the moon at some former period was almost in contact with the earth, or was perhaps a piece broken off her, the presence of gases on the moon, if it were possible for them to remain there, might be assumed with increased certainty. Admitting that our knowledge on the subject is not positive, we may at least adopt the hypothesis as a probable one. It is the only one which satisfactorily accounts for the want of any atmosphere on the moon.

The mean velocity of gaseous molecules is in inverse proportion to the square root of the molecular weight, and in direct proportion to the square root of their absolute temperature; the freezing point of water being 492° F. above absolute zero. Taking the molecular weight of hydrogen as unity, that of oxygen is 16. The square root of 16 is 4, and the mean velocity of oxygen, therefore, is to that of hydrogen inversely as 4 to 1 at the same temperature. The mean velocity of hydrogen at the freezing point is about 6,000 feet per second That of oxygen, therefore, is 1,500 feet per second. The molecular weight of nitrogen being 14, of which the square root is 3·74, the mean velocity of nitrogen at the freezing point is 1,600 feet per second. These velocities are increased by nearly one-half at twice the absolute temperature, which is 524° F.; are doubled at four times the temperature, or 1,508° F.; are trebled at 3,968° F., and quadrupled at 7,412° F.

On the other hand, they are reduced to one-half at 337° below zero F., and to one-fourth at 430° below zero F., or 30° above absolute zero.

The temperature of the moon's surface when exposed to sunshine, which is continuous for fourteen days, cannot be very low. Various experiments have made it probable that it rises above the boiling point of our thermometers. If it rises at any time to 300° F., this temperature is sufficient to drive away an atmosphere of hydrogen, even if the mean velocity of its molecules were also their highest. We may say at once, therefore, that hydrogen could not remain in a gaseous form on the surface of the moon. But oxygen and nitrogen, or gases of still greater weight, are what may be expected, and they would as certainly remain at any temperature possible at the moon's surface, unless their highest velocities greatly exceeded the mean. Assuming that the temperature reaches 300° F., the mean velocity of oxygen at that temperature is 1,900 feet, and of nitrogen 2,000 feet per second. To carry these away from the moon, the maximum velocity cannot be less than four times as great as the mean.

If we take heavier gases, such as chlorine and carbonic acid, with relative weights 35 and 22, their mean velocities at 300° F. will be respectively about 1,250 and 1,600 feet per second, and to carry these away the maximum velocity must be six or seven times as great as the mean.

It is not probable, however, that the whole atmosphere of the moon, if there were one, would acquire the temperature of the heated surface.

The temperature of our own atmosphere, at considerable heights, is much lower than the surface temperature, and the relation between the two has next to be considered.

The air gets its heat from four sources. The direct rays of the sun pass through it, and warm it to some extent. The rays reflected from the earth pass through it again. The heated earth radiates its heat, also through the atmosphere; and the air in contact with the heated surface receives heat directly by conduction, and carries it by convection currents to the air above. And the heat thus acquired is only lost by direct radiation from the air itself into space. The cooling effect of the expansion of heated air is only local, and does not affect the atmosphere as a whole, because the work done by the portion which expands is work done on the other portions.

But radiation takes place very slowly from the elementary gases, and as these, during the day time, are continually receiving heat from the four sources referred to, their temperature cannot fall to a very low point, except at night. The air chilled by radiation at night, at great altitudes, naturally descends, but the descent is gradual, and is stopped by the return of day, and the general result must be a tendency to the production of a cold stratum at an intermediate height, between warmer air which it has displaced, and which has risen above it, and the portion, also warmer, nearer the earth's surface, which it has not had time to penetrate. This will account for the considerable cold met with a few miles above the surface, while if we could ascend to a height of forty or fifty miles, we should probably find the air not colder, but warmer than below.

There is further evidence that the cold of these higher regions is not extreme, in the actual height of the atmosphere. The density of a gaseous atmosphere is, in all parts of it, proportional to the pressure, and the pressure again at any point being proportional to the density of the portion above it, pressure and density decrease in a geometrical ratio in ascending from the earth. If at a certain height the density is reduced to one-half, at twice the height it is reduced to one-fourth; at three times the height to one-eighth; at four times to one-sixteenth; at five times to one-thirty-second, and so on. The density of our atmosphere is reduced to one-half at a height of about three and a half miles. It follows that it is reduced to one-millionth at about seventy, and to one-billionth at about one hundred and forty miles, on the supposition that the temperature is uniform. If the temperature is lower in the upper than in the lower portions, the density will decrease more rapidly, and if the upper temperature were so low as to approach the point of absolute zero, the decrease to any given density at great heights would occur at about half the height required when the temperature is uniform. The density of our atmosphere, therefore, is reduced to one-billionth at not more than one hundred and forty and not less than seventy miles above the surface.*

What, then, is the condition of the air when reduced to one-billionth of its density at the earth's surface? The weight of a column of such air, one hundred miles long, and one square inch in section, is about $\frac{1}{500,000}$th of a grain. †

Now, great numbers of meteors pass through the atmosphere between the heights above mentioned, and as their average speed is roughly known, and the resistance they encounter is sufficient to make their path a luminous one, the amount of that resistance can be approximately estimated. In highly attenuated air it cannot be greater than is due to the total mass displaced by the moving body; that is to say, if the moving body encountered in vacuo another body, at rest, equal in weight to the column of air through which it passes, the resistance would be at least as great as that of the column of air. The greatest possible resistance that any substance at rest can offer to a moving body passing through it is evidently the weight of the entire column in front of the moving body, in the direction of its motion (the entire column through which it would pass and which it would displace, if it continued moving as far as the substance extends), added to the lateral friction, or, what is nearly the same thing, the force of adhesion between the column to be displaced and the rest of the substance. If the column were a rigid rod which the moving body had to push before it, through the surrounding material, the weight of the rod and the friction together would make the maximum of resistance. In piercing solid bodies, the friction and cohesion are nearly everything, and the weight may be to a great extent disregarded; but in highly rarefied air the weight is the chief element, and the friction may be disregarded. And the rarer the air, the less important becomes any part of the column beyond that actually passed through. A body moving at a high velocity, doubles up, as it were, the air it encounters, and so condenses and carries along with it in this condensed form a long column which has not time to escape laterally; and if there is air in front of this column dense enough to offer an appreciable resistance to its expansion in that direction, this is so much added to the total resistance encountered by the moving body. This, however, in highly rarefied air is probably too small to be considered, and we may finally conclude that when a meteor passes through the higher portions of the earth's atmosphere, the resistance it meets with cannot be sensibly greater than would be offered by a body at rest, equal in weight to the column of air through which the meteor has passed. Experiment shows that this is the case even in air of ordinary density. If a cannon shot weighing 32lbs., with sectional area of 30 square inches, is fired at a target 1,000 yards off, with an initial velocity of 1,600 feet per second, the column of air passed through (1,000 yards by 30 square inches, = 1,080,000 cubical inches) weighs 48lbs. If 48lbs. weight were added to the 32lbs., the velocity, instead of being 1,600, would be reduced to 640 feet per second, which is much less than the velocity with which the ball strikes the target.

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* The volume of an atmosphere is approximately as its mean absolute temperature. The general rule from observation is, that the height at which a given density is arrived at is less than it would be if the temperature were uniform, by about $\frac{1}{870}$th part for every degree Fahrenheit by which the temperature at that height is less than at the surface.—See Young's *Mathematics; Law of Mariotte and Boyle.*

† 100 cubic inches of air weigh 31 grains at normal density. Therefore $\frac{100 \times 1,760 \times 36 \times 31}{100} = 1,964,160$ grains = the weight of the column at normal density, and this divided by one billion = $\frac{1}{500,000}$th of a grain, nearly.

Again, if such a shot is fired upwards, the weight of the column of air above it is 450lbs. (30 square inches × 15). If this weight were added to the ball, the velocity would be reduced to one-fifteenth, which is much in excess of the real reduction at any initial velocity. Suppose it were possible to discharge the shot at a speed of fifteen miles per second; this would be reduced to one mile per second. A body projected upwards, in vacuo, at a speed of one mile per second, would ascend only eighty miles before it fell back. We cannot doubt that a shot fired upwards through the air, from the earth's surface, with twice the velocity necessary to carry it, in vacuo, to an infinite distance, would ascend, at any rate, much more than eighty miles.

Now, suppose one of the meteors to be a small body with a sectional area of one square inch, and weighing 1,000 grains (about two ounces), moving at the rate of thirty miles per second. Meteors seen at great heights and moving with high velocities are seldom luminous for more than three seconds. The column of air passed through in that time would therefore not exceed one hundred miles in length. The weight of this column in air reduced to one-billionth of an atmosphere in density is $\frac{1}{500,000}$th of a grain, and the maximum effect of its resistance will be the heat due to the impact of a body weighing $\frac{1}{500{,}000}$th of a grain, moving with the velocity of the meteor. This is sufficient to raise the temperature of the column of air, weighing $\frac{1}{500{,}000}$th of a grain, two million degrees Fahrenheit.* The specific heat of meteoric matter is probably about half that of air, and the same quantity would therefore be raised to twice the temperature, but the weight of the meteor itself (1,000 grains) being 500 million times as great as that of the column of air, nothing but the merest film upon its surface could be rendered luminous. The heat would, in fact, be sufficient to raise the 250th part of a grain of such matter to about 2,000° F., or to white heat.

The latent heat disengaged by the compression of the air is not included in this estimate, but though it might be sufficient to make the compressed air itself luminous, this applies only to $\frac{1}{500{,}000}$th of a grain of matter, and as the resistance has been over, and not under, estimated, we may be satisfied that the 250th part of a grain is the greatest quantity that could be raised to white heat in these circumstances.

Is it possible that so small a quantity of matter at that temperature can be visibly luminous when looked at through the atmosphere at the distance of the meteors, which is seldom less than one hundred miles? It does not appear to be quite impossible. A gas flame one inch square and one-fiftieth of an inch in thickness contains about this quantity of luminous matter, and at a very high temperature it might possibly be seen many miles away. But the fiftieth of an inch is a very small thickness. A flame of this kind consumes

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* The heat due to the impact of a body moving at the rate of 223 feet per second, and of the specific heat of water, is sufficient to raise its own temperature one degree Fahrenheit. The specific heat of air is 0·24; therefore

$$\frac{\left(\frac{30\text{ miles}}{223\text{ feet}}\right)^2}{0{\cdot}24} = 2{,}102{,}192,$$

the number of degrees by which the temperature of the column of air may be raised by the impact supposed.

more than half a grain of gas in a second, and the quantity incandescent at any instant is doubtless more than the 125th part of this. In electric lights, and in the lime light, the quantity of incandescent matter is probably no less.

We must conclude that if the passage of meteors through air reduced in density to one-billionth of our atmosphere is sufficient to make them visibly luminous, it cannot be more than sufficient; that a greater density is probably required, and that a less is inadmissible. Now, the density of the air is reduced to one-billionth at a height of seventy miles, if the upper temperature descends to nearly absolute zero, and as meteors are luminous at much greater heights, the temperature must be higher. If it is as high as at the earth's surface, the reduction of density to one-billionth will not occur till the height of one hundred and forty miles is reached. It is perhaps doubtful whether meteors are ever visible at so great a height, and the upper temperature, therefore, may be somewhat lower than at the surface. The general conclusion is that at a height of something more than one hundred miles the temperature of the air is not likely to be 100° below the freezing point, and that its density is about one-billionth of our atmosphere.

Now, at this density, the mean free path of the molecules, according to Mr. Crookes' calculation (*Nature*, No. 592, p. 421), is about fifty miles.* Practically, therefore, each molecule may be regarded as a separate projectile discharged into open space. At this point of extreme tenuity we have either reached or are closely approaching what is practically the outer boundary of the atmosphere as a body of gas. For when the mean free path of the molecules is fifty miles, the mean interval between their encounters is several minutes, and most of those projected outwards will fall again by the force of gravity before they meet with any others. In this condition the molecules of the gas no longer support each other, as in ordinary gas, and they must be regarded as separate projectiles discharged from the upper surface of the atmosphere where it still exists in the ordinary gaseous form. How far they will go depends on the velocity of their projection, which is the molecular velocity of the gas. The mean velocity at the temperature shown to be probable does not differ greatly from about 1,400 feet per second. This speed would carry them to a height of about six miles above their starting point, which is the upper surface of the normal atmosphere, but such molecules as moved faster than the mean would ascend higher. If the maximum velocity were five times the mean, some molecules would be carried one hundred and fifty miles. If it were ten times the mean, some would be carried nearly six hundred miles. As the starting point is already more than a hundred miles above the earth, there would, in the latter case, be molecules of air, or rather of oxygen and nitrogen, at a height of seven hundred miles above the earth. It has, I believe, been supposed that there are some indications of the presence of gaseous matter at heights nearly as great, and it is to that extent a probable conclusion that the maximum velocity may be as much as ten times the mean. But if it were greater than this, the earth's atmosphere would extend to an improbable distance. At fifteen times the mean there would be oxygen and nitrogen at one thousand miles above the surface, and if twenty times the mean, then at more than two thousand miles.

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* Not, of course, their distance from each other, but the distance a molecule will traverse, on an average, before it strikes against another molecule. The molecules, at this degree of tenuity, may still be within a hair's breadth of each other; but they themselves are so small that millions can pass side by side in the space of a hair's breadth.

Ten times the mean velocity must therefore be taken to be the extreme limit of a maximum velocity, so far as this evidence goes.

Let us now consider what is suggested by the condition of the planet Mars. Mars has an atmosphere which is presumably not much unlike our own. We can hardly doubt that nitrogen or oxygen, or both, are its chief constituents. The velocity that would carry matter permanently away from Mars is about 16,000 feet per second.* Supposing his atmosphere to be similar to our own, and its temperature somewhat lower, a mean velocity of about 1,200 feet per second, in its molecules, must be taken as probable. If so, the gases would leave it if their maximum velocity were as much as thirteen times the mean; we conclude, therefore, that it is less than this; we must conclude, in fact, that it is very much less, unless the cold in Mars is great enough to reduce the mean velocity much below the 1,200 feet assumed. For the force of gravity on Mars is little more than one-third of that on the earth's surface, and a velocity of a mile and a half per second would carry his atmosphere to a height of six hundred miles. This is the highest that can be probable, considering his size.†

It appears, then, that at the probable temperatures near the surfaces of the three bodies, the maximum velocity of gaseous molecules must be much less than thirteen times the mean in the atmosphere of Mars; less than ten times the mean in the earth's atmosphere; and more than five times the mean on the moon's surface. It must therefore lie between these, and on these data we may assume that it is in fact about seven or eight times the mean velocity.

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* Taking the diameter of Mars at 4,170 miles, his mass and radius as unity, and the earth's mass and radius as 9·8 and 1·9, $\frac{1{\cdot}9^2}{9{\cdot}8} \times 32{\cdot}2 = 11{\cdot}8$ feet = G at surface of Mars. $\sqrt{2RG}$ $\sqrt{4{,}170 \text{ miles} \times 11{\cdot}8 \text{ feet}} = 16{,}118$ feet.

† The distance to which any velocity of projection will carry a projectile upwards from the surface of a sphere, in vacuo, is $\frac{2\,R^2G}{2RG - V_2} - R$, where R is the radius of the sphere, G the acceleration of gravity at its surface, and V the velocity. As V is the only variable, the quantities, for the earth, are $\frac{191{,}750}{48{\cdot}4 - V^2} - 3965$ = distance above the starting point, in miles, the velocity being taken in miles per second. The formula for Mars is $\frac{19{,}430}{9{\cdot}3 - V^2} - 2{,}085$, and for the moon $\frac{2{,}150}{2{\cdot} - V^2} - 1{,}076$. If the starting point is above the surface, the distance carried will be greater; but in the case of the earth the difference is not considerable if the starting point is less than two hundred miles above the surface, and if the velocity does not exceed three miles per second.

It does not follow that the same relation would hold good at other temperatures, but we may suppose this to be probable because the cause of the difference can hardly be other than uniform.

There is one other gas, however, which needs separate consideration. The mean velocity of hydrogen at the freezing point is 6,000 feet per second, and seven times this velocity would be rather more than is necessary to carry the molecules of hydrogen altogether away from the earth. Now, our atmosphere contains no sensible quantity of hydrogen, and though it is not produced in a free state in large quantities by natural processes, small quantities are continually set free, in volcanic discharges, in coal mines, and in some organic processes. In the course of ages an appreciable quantity must have accumulated in the air if it had not by some means been removed. Lightning passing through it in the air would no doubt convert it into water; but the dilution of this gas in the atmosphere is necessarily so extreme that this effect would not extend beyond the line of the flash itself, and it is difficult to believe that the air could be kept free from hydrogen by this means. Chlorine would combine with it in sunlight, but chlorine is never found free, and if it were, the great difference in the specific gravities of the two gases would go far to keep them apart. There seems good reason to conjecture that free hydrogen, if discharged into the atmosphere, does actually leave it in virtue of its molecular velocity.

It is clear that hydrogen could not be retained in a free state by bodies smaller than the earth, and as its frequent discharge from such bodies is very probable, we may suppose that the hydrogen thus liberated falls ultimately into the atmospheres of larger bodies. Such planets as Jupiter and Saturn can certainly retain it. The velocity required to carry matter away from Jupiter is about thirty-three miles per second. The seventh part of this is between four and five miles, and the temperature required to produce this mean velocity in hydrogen is nearly 10,000° F.

Hydrogen, we know, is an important element in the atmosphere of the sun; doubtless because the sun's attraction is powerful enough to retain it even at the sun's temperature. To carry it away from the sun, a velocity of nearly four hundred miles per second is necessary. If the necessary mean velocity were, as supposed above, one-seventh of this, it would be more than fifty miles in a second, and to give this to the molecules of hydrogen, the temperature must be about a million degrees F.

At low temperatures, gases can only escape permanently from bodies smaller than the earth; but they may escape from the larger bodies of the universe if the temperature is at any time sufficiently high. What would be the fate of these escaping gases? They pass off in that form of extreme attenuation in which their separate molecules move for indefinite distances without encountering each other, and there is nothing to bring them back into closer relationship till they fall, as they ultimately must do, into the atmosphere of some attracting body. In their passage through space they encounter the resistance of the ether, which is in fact their rate of cooling by radiation; the temperature of a separate molecule projected in this way being the energy of its onward motion. This resistance will gradually bring them towards a state of rest, and they will then fall towards the nearest, or the most powerful, centre of attraction.

The limit of the velocity of gases has a special interest in general physics, because it is closely related to the limit of motive force in the universe. Apart from gravity, the agencies by which motion is produced in inorganic bodies are chiefly of an explosive nature in their origin or their application. A moving body, whatever its size may be, cannot cause another body to move faster than itself by direct collision. An air-gun, for example, cannot discharge its shot with a speed greater than that of the gaseous molecules; and this must be the case in all explosions which are due to the compression of gases still retaining the gaseous form.

A moving body, however, may indirectly be the cause of much more rapid motion than its own. A blow near the pole of a sphere may set it spinning with an immensely greater velocity at the equator. Or a blow on the short end of a lever in any form may have this result. Nor is it clear that the maximum velocity of a gas is the greatest speed at which its molecules have moved in passing from a solid or liquid to a gaseous form. We cannot, therefore, learn by this method alone what is the highest speed attainable by explosive agencies.

If, however, the explosion of one pound of gunpowder will drive out a ball weighing six pounds with a speed of 1,600 feet per second, we must conclude generally that the blow delivered by the powder must have been given with a velocity at least seven times as great, even if it could be conceived of as given by the whole mass of the gunpowder. The velocity of the gaseous molecules would thus be more than 11,000 feet per second. Now, the mean molecular velocity of the gases of gunpowder cannot be greater than that of nitrogen, which is 1,600 feet per second at the freezing point, and to raise this to 11,000 feet would need a temperature of not less than 25,000° F., which is beyond the probable temperature of the explosion. But if at the instant of passing into a gaseous state the elementary atoms are dissociated, and their relative weight thereby reduced to one-half, a mean velocity of 1,600 feet would be raised to 2,300 feet at the freezing point, and would become 11,000 feet at a temperature of about 12,000° F.

The explanation is scarcely sufficient, however. Part of the gaseous molecules may be supposed to strike the ball immediately, and the rest on their rebound from the side of the powder chamber so quickly afterwards as to be practically efficient; but the energy of the powder is, in fact, divided between the ball driven in one direction and the gun in another, and the whole mass of the powder cannot transfer its whole motion to the ball. Unless, therefore, the actual internal temperature of the gases at the instant of liberation is really much beyond 25,000° F., it seems necessary to suppose that the velocity with which the atoms of the gases fly apart at that instant is much greater than that which, as gases, they afterwards retain.

The case here considered is that of a projectile discharged with a speed of 1,600 feet per second. Far higher velocities, however, are possible, at least in theory. When the weight of the projectile is as great as that of the gases by which it is expelled, the *mean* velocity of those gases is the greatest that can be given to the projectile. But if portions of the gas are moving at a speed greater than the mean, they may give a higher velocity to a smaller body if they can be made to strike it effectively. In practical gunnery a higher velocity is not necessarily given by making the weight of the powder much greater than that of the shot; but there are mechanical reasons for this. If the maximum velocity of gaseous molecules may, as I have suggested, be taken as about seven times the mean velocity, then, in hydrogen for example, some of the molecules are moving at the freezing point with a velocity of not less than eight miles in a second, and this would become more than fifty miles at a temperature of 25,000° F. We might give this velocity to a projectile of proportionate weight if we could use for our explosive, hydrogen, liberated at this temperature, and in such a form that the molecules having the maximum velocity were the effective ones; and this would again be doubled if the hydrogen atoms were dissociated. Whether this will ever be possible here may well be questioned, but it is not unlikely that we see the actual process operating in the sun when jets of hydrogen appear to rush at otherwise incredible speed beyond his visible atmosphere.

NOTE.—It appears that in any atmosphere round an attracting sphere, the height at which the whole mass of air is divided into two halves of equal weight depends on the nature of the gas, the temperature, and the force of gravity, and is not affected sensibly by the total quantity. For suppose the quantity doubled; the weight of the upper half is doubled, and the lower half being also doubled in quantity, but under twice the pressure, will have its density doubled, but its volume unchanged.

It appears also that when gravity and temperature are the same, the height of the lower half atmosphere will be inversely proportional to the relative weight of the gas. For suppose hydrogen, with relative weight about $\frac{1}{14}$, to be substituted for air, in such quantity that the total mass is the same, the pressure of the upper half atmosphere will be the same, and the volume of the lower half will therefore be fourteen times greater.

It appears, further, that the height of the lower half atmosphere will closely approximate to half the height to which the mean molecular velocity of the gas, considered as a projectile force, would carry a projectile upwards from the surface of the sphere. For this is known by observation to be the case in the earth's atmosphere. The height of the lower half is about 3½ miles, or more nearly 3·4 miles. The velocity which would carry a projectile to twice this height, in vacuo, from the surface, is 1,510 feet per second. The mean' molecular velocity of the mixed nitrogen and oxygen of the air is 1,510 feet at -22^0 F.

The mean temperature of the first 6·8 miles of the atmosphere, as a whole, is probably not quite so low as -22^0, but it cannot be very much higher. At the same time the molecular velocity of the air is somewhat less than that of its nitrogen and oxygen, from the presence of carbonic acid, which is heavier, and of aqueous vapour, which is an imperfect gas. Allowing for this, the approximation to the velocity of 1,510 feet is so close, that we can hardly doubt their practical identity.

The relation between these heights must also hold good, whatever the gas may be, and in the case of any attracting sphere.

For the height of the half atmosphere, the square of the molecular velocity at the same temperature, and therefore the projectile height, are all of them inversely as the relative weight of the gas composing the atmosphere. And if the force of gravity varies, the height of the half atmosphere is inversely as the pressure, and therefore as the force of gravity; and so is the projectile height near the surface. And if the temperature varies, the height of the half atmosphere and the square of the molecular velocity both vary directly as the absolute temperature.

The height of the upper half of the atmosphere is not subject to the same laws, but practically it must always be nearly the same multiple of the lower half. Whatever the height of the lower half may be, the density is reduced to about one-billionth at about forty times this height, and an atmosphere of any density consistent with the constitution of a gas is practically at an end when reduced to this extent. The decrease of gravity in ascending need hardly be considered.

It seems possible, therefore, to state concisely a general law of atmospheres, depending on the relative weight of the gas, the force of gravity, and the temperature. The relative weight and the temperature determine the molecular velocity. The velocity and the force of gravity determine the projectile height. Half this height is the depth of the lower half atmosphere, and forty times this depth is the limit beyond which there can be no atmosphere of an appreciable kind.

Some curious results appear to follow. At ordinary temperatures, no atmosphere of oxygen or nitrogen can be so much as one hundred and forty miles high on any planet larger than the earth. On Jupiter, where gravity is 2¼ times as great, such an atmosphere could not be appreciable at a greater height above the surface than sixty miles.

An atmosphere of hydrogen on Jupiter might be appreciable at a height of nine hundred miles if in sufficient quantity. But if there is any gas whose relative weight is to hydrogen as that of hydrogen to air, Jupiter might have an atmosphere of it thirteen thousand miles deep; and he could hold a gas of this kind, for its mean molecular velocity at the freezing point would be about four miles per second, while thirty-three miles per second would be necessary to carry it away from him. Such a gas could not remain on the earth, and its absence here does not therefore entitle us to say that it has no existence. Many things connected with the physics of the larger bodies point to the probable presence in the universe of some materials far lighter than anything we are acquainted with. If they exist, it is on the larger bodies only that they can be found, since they could not be retained by the smaller ones.

THE TRAINING OF SAILORS AND EXPLORERS.

By CLEMENTS R. MARKHAM, C.B.

The nations which, during the last four centuries, have taken part in discovery and geographical research, have all been impressed with the necessity for instructing their explorers by land and sea in all such knowledge as would best enable them to perform the service entrusted to them with efficiency. There seems to be no such impression in England at the present day among many of those whom it most concerns. The Spaniards, Portuguese, Dutch, and our own ancestors felt that their ships would not be safe on long voyages, that their travellers and maritime adventurers would make their journeys and voyages without bringing back any useful results, unless instruction was provided in all the knowledge that could be of service to them. It was found that in proportion as attention was given to the training and instructing of sailors and travellers by land, voyages and adventures were more profitable and discoveries were more successful and important.

Moreover, the instructed explorers, in numerous instances, improved upon the education they had received by bringing their acquired experience to bear upon it; while ignorant mariners returned as they went, without in any way increasing the general stock of knowledge. Such was the view taken by our ancestors, and it was this consideration which led to the efforts they made to supply the means of instruction.

I propose, in the remarks I shall submit to the Institute on this subject, to refer to the system of instruction adopted by Spain, and her Council of the Indies, when in the height of her greatness as a discovering nation, and to pass briefly in review her writers on navigation and surveying; and I think it will be seen that Spain's maritime greatness could, in the opinion of her rulers, be maintained only by keeping up the standard of knowledge among her sailors and explorers. In Holland, experience taught the same lesson. When our own country began to enter upon her glorious career of discovery and maritime adventure, the absolute necessity for educating and thoroughly training our explorers was immediately felt. At first we sought for aid from Spain, and strove to take example from her in this respect. But soon our own trained seamen began to improve upon old methods, while our mathematicians provided books and instruction for their guidance. I will dwell upon these early efforts and upon their results; and I will endeavour to establish to your satisfaction the fact that our maritime greatness, in former days, was due to the care taken by our ancestors to supply instruction to our adventurers, and to the way in which the ablest and best among them profited by the advantages thus received. The conclusion will then, I believe, be inevitable that the same causes would now produce the same effects, and that if, in proportion to our increased wealth and population, equally good means of instruction are not provided, and equal importance is not attached to the subject, a mistake is being made. Finally, I will lay before you the existing provision for supplying the required instruction in Great Britain, as compared with the systems adopted in some other countries; and I will ask you to form your own conclusion as to whether some improvement is not very urgently needed here.

In the very dawn of the history of maritime discovery, there is a remarkable example of the value of careful training in enabling an explorer to improve upon the instruction he has received, and to make his theoretical learning bear useful practical fruit. In the fifteenth century there lived at

Nuremburg the most learned mathematician of his age. John Müller, better known as Regiomontanus, published a work on plane and spherical triangles with tables of sines, completed the translation of Ptolemy's "Almagest," invented several astronomical instruments, and published the first almanac. Among the pupils of Regiomontanus was a young Nuremburger, named Martin Behaim, who studied to such good purpose that, when he entered upon the life of a merchant adventurer in 1479, and went to Portugal, he was a skilful mathematician and cosmographer. He was a man of action and a good practical seaman. He accompanied Diogo Cam on his voyage along the coast of Africa to the mouth of the Congo in 1484. On his return he received the order of Christ from the King of Portugal, won the hand of a daughter of Jobst von Hurter—a nobleman of Bruges who had settled in the Azores, and passed the remainder of his life on those islands, making occasional visits to Lisbon. When he died, in 1506, he left behind him a number of charts, and the famous globe, now at Nuremburg, which is the most ancient in existence. Martin Behaim had learnt the use of the astrolabe from Regiomontanus. It was this theoretical training which enabled him, after having acquired practical experience, so to apply his knowledge as to produce a useful invention. Behaim adapted the astrolabe to the uses of navigation in 1480, and thus supplied to mariners that instrument for taking the altitude of the sun which guided Vasco da Gama in rounding the Cape, and Magellan in circumnavigating the globe. This illustrious Nuremburger was one of the first explorers who used his practical experience to improve upon his theoretical education. Both were necessary. Without having been well grounded in all existing knowledge, his experience would have availed him little. Without experience he could not have usefully applied his knowledge. It was the combination of knowledge and experience which resulted in his invention of an instrument of inestimable value then, and for many years afterwards. So that at the very opening of maritime history we meet with a striking example of the importance of thoroughly grounding and training sailors and travellers in the knowledge that will be useful to them.

When the Spaniards began to send forth expeditions into unknown seas, and to explore the interior of vast continents, they were soon impressed with the necessity for thoroughly grounding and instructing not only their pilots and seamen, but also their explorers by land. With this object, the office of Cosmographer was established in the Council of the Indies, whose duties were not only to superintend the preparation of charts and sailing directions and to advise the Council in matters relating to navigation, but also to teach the subjects of the King of Spain. In the Royal Ordinances it was decreed that the Cosmographer, and his assistants, should deliver a course of instruction to extend over three years. The course was arranged as follows:—

In the first year, from September to Christmas, the four rules of arithmetic, the rule of three, extraction of square and cube roots, and fractions were taught; as well as the "*Sphera Mundi*" of Sacrobosco, the universal text-book in the ancient schools of navigation, which was first printed in 1472, and passed through many editions. Sacrobosco himself was, in plain English, one John Holywood, a Yorkshireman from Halifax, and his work is a paraphrased translation of part of Ptolemy's "*Almagest.*" From Christmas to April the pupils learnt Perbach's theory of the plants, which was first published in Venice, in 1480; and from April to the midsummer holidays they studied the Alphonsine tables, the famous astronomical work of Alfonso the Wise, King of Castille, which first appeared in 1252.

The course for the second year commenced with the first six books of Euclid. During April and May arcs and chords, right sines, tangents, and secants were learnt, and then the spherical triangles of Regiomontanus. The rest of the second year's course was devoted to a study of Ptolemy's "*Almagest.*"

The third year was commenced with lessons in cosmography and navigation. Then the use of the astrolabe was taught, and the methods of observing the heavenly bodies and their movements. Finally, the use of the globes, and of various astronomical and mathematical instruments was explained.

Thus the Spanish candidates for appointments as pilots and captains, all went through a three years' course of study before they were considered to be qualified for any responsible post. When we read of the famous discoveries of this great people, of their successful voyages and wonderful adventures, we must remember that the Spanish discoverers and explorers were carefully instructed in all the knowledge of those days. It is to such training that a great deal of their success was mainly due; and we ought to bear this in mind when we read of, and reflect upon, the great geographical achievements of the Spaniards.

The lectures were given at the "Casa de Contratacion," in Seville, from the time of Charles V.; and some of the Cosmographers not only taught the Spanish mariners by word of mouth, but at least three of them, Alonzo de Chaves, Jeromino de Chaves, and Rodrigo Zamorano, published useful works on navigation. We are told by Richard Hakluyt, who had made diligent enquiries, that, after the pupils had completed their courses of study, there was "straight and severe examining, before the Chief Pilot, of all such masters as desired to take charge to the West Indies."

The first navigation book was the "*Suma de Geografia*" of Martin Fernandez Enciso; and here again we have the case of a learned man who afterwards gained practical experience at sea which enabled him to produce a useful work. Enciso undertook a conquest of part of South America, in partnership with Alonzo de Ojeda, one of the companions of Columbus. He went through many strange adventures, and his story is mixed up with the first appearance of Vasco Nuñez de Balboa and Francisco Pizarro on the stage. As an adventurer, Enciso does not appear in an amiable light, for he was an enemy of the heroic discoverer of the South Sea. But as an author his name should not be forgotten. The "*Suma de Geografia*" contains the art of navigation as it was then understood, tables of declination, definitions, and an account of all the countries of the known world. It was the first answer to a demand for information which arose when all Spaniards of enterprise began to crowd westward in search of adventures and of fortune. The first edition of the "*Suma*" appeared at Seville in 1519, the second in 1530.

But it was soon followed by two works which secured more permanent popularity. The art of navigation by Martin Cortes, which was published at Seville in 1551, and dedicated to Charles V., contains definitions, tables of minutes in a degree of longitude on each parallel of latitude, explanations of the motions of sun and moon, and of the machinery and use of clocks, construction and use of plane charts, of the compass, the astrolabe, and cross-staff. Cortes was the first to suggest a magnetic pole, different from the pole of the earth. The other work on navigation, by Pedro de Medina, appeared at Valladolid in 1545, but never attained to the same popularity as the "*Arte de Navegar*" of Cortes. Medina defends, while Cortes exposes, the errors of the plane chart, and the latter is more sound on the question of compass variation, concerning which Medina talks much nonsense. Later Spanish writers improved upon the works of Cortes and Medina, and many editions were printed to meet the requirements of students.

I have referred to these Spanish works on navigation, and to the system of instruction at Seville, because it ought to be remembered that the Spaniards would never have made their great discoveries, and afterwards have surveyed and described them with such remarkable accuracy and detail, if attention had not been given to the instruction of their sailors and surveyors. They made excellent charts of the coasts of South America and Mexico, and of Magellan's Straits, and their enemy, Sir Richard Hawkins, bears testimony to the care and skill with which they navigated their ships. One reason that full justice has never been done to the Spaniards, as skilled mariners, is that their Government maintained a policy of strict secrecy. Many excellent charts and memoirs have never yet seen the light. As one out of numerous instances of unwise suppression, I may mention that, after Captain Moresby had published his discoveries at the eastern end of New Guinea in 1876, a set of accurate charts of the very same ground was discovered at Simancas, drawn by Diego de Prado y Tovar in the year 1606, from the surveys of Torres.

But I believe I have said enough to show that Spain, in the height of her power, attached the greatest importance to the thorough training and instruction of her sailors and explorers; and that her discoveries and successes could never have been achieved without this wise and necessary provision for qualifying her sons to perform those great deeds the fame of which will endure for ages to come.

When the United Provinces began to rival Spain in maritime enterprise, the Dutch mathematicians and geographers kept pace with the sailors and explorers in their improvements and discoveries. Reinerus Gemma, a native of Friesland who lived in the first half of the sixteenth century, was the first to suggest the method of finding longitude by means of a watch showing time at the place of departure, and of apparent time at the place of observation. He also invented a new cross-staff, and constructed astronomical instruments. His pupil, Gerard Mercator, published the famous terrestrial globe and numerous maps, while Abraham Ortelius produced the "*Theatrum Orbis Terrarum,*" which was the base of all subsequent geographical studies. The labours of these great men, with the treatise on navigation by Coignet and the translations of Medina, formed the materials for instructing the young sailors of Holland in the sixteenth century. Among many others who received careful instruction, the career of Lucas Wagenaar is an example of the way in which theoretical training, when united with long experience, often bears valuable fruit.

Young Wagenaar was born at Enkhuizen in about 1550, and served at sea from his boyhood. But he had received a good training in mathematics and navigation, and he became one of the best pilots in Holland. His "Spieghel der Zeevaardt," engraved at Leyden in 1584, was the first marine atlas ever published, and in subsequent editions very extensive and valuable additions were made to it, including a chart of Norway by Willem Barents. The name of this great Arctic explorer suggests an example of another Dutch worthy who had been carefully trained in the art of navigation. In his northern voyages he regularly observed with the astrolabe, cross-staff, and quadrant; and Linschoten describes him as having great knowledge of the science of navigation. He was a native of Ter Schelling, off the coast of Friesland, and this little island still has a navigation school. The Dutch, in former days, like the Spaniards, attached the greatest importance to the thorough education of their sailors and explorers; and, in like manner, it was to the care and trouble taken to instruct them that the success of their memorable voyages of discovery is due.

When our own country, during the reigns of the Tudors and Stuarts, began to enter upon that career of discovery by land, and of daring maritime adventure, which soon placed us in the foremost rank among nations, the necessity for instruction in the art of navigation was at once felt. It was at the urgent request of one of our earliest Arctic navigators, Stephen Burrough, that Master Richard Eden undertook the translation of the navigation book of Cortes. It first appeared in 1561, and was very generally used, passing rapidly through ten editions. But the work on navigation used by Sir Martin Frobisher, during his first voyage in 1576, was a Spanish edition of Medina. His other appliances were a great globe, a nautical sphere, a clock, an astrolabe, a cross-staff, compasses, hour glasses, and charts.

The first English navigation book that was in general use was the "*Regiment of the Sea,*" published by William Bourne in 1573. It was designed merely as a supplement to Cortes, whom Bourne often quotes; but it contains many new methods and suggestions, and Bourne was the first to describe the log and line for estimating the rate of a ship. Bourne was followed by several other writers, during the reign of Elizabeth, who devoted themselves to the laudable object of supplying instruction to sailors and travellers. John Blagrave, a country gentleman who lived at Southcote Lodge, near Reading, and died there in 1611, invented a new kind of astrolabe, and wrote what he called "a necessary and pleasant solace for navigators." Robert Tanner, in 1587, published "A sure safety for Sailors;" Thomas Blundeville contributed treatises on the art of navigation, "verie necessary to be read and learned by all young gentlemen that are desirous to have a knowledge as well in cosmography and geography as in navigation." This book, which first appeared in 1594, was very popular, and quickly went through several editions. Dr. Thomas Hood was another eminent author and teacher of navigation in those days. He published works on geometry, and on the use of the globes "most plainely delivered in form of a dialogue; containing most pleasant and profitable conclusions for the mariner."

Edward Wright, who made the voyage with the Earl of Cumberland in 1589, was, however, the mathematician whose labours were most serviceable to the navigator, for he discovered the projection for sea charts which is generally attributed to Mercator. In 1599 he published a book in which he fully explains the principle of the projection, and gives a table of meridional parts. Wright also worked, in conjunction with the geometrician, Henry Briggs, to introduce the use of logarithms. He translated Lord Napier's "*Logarithmorum Descriptio,*" which was published by his son Samuel, while Briggs undertook a journey to Edinburgh to discuss the matter with Napier, and, in 1624, gave his work on logarithmic arithmetic to the world. Briggs's tables for the improvement of navigation were published in 1610, with the second edition of Wright's book.

Terrestrial magnetism was also studied in England, with useful practical results, during the reign of Elizabeth; and the variation of the compass has been observed since 1580. In 1581 William Borough published his "*Discourse of the Magnetic Needle;*" and "*The New Attractive,*" by Robert Norman, announced in 1585 the discovery of the dip of the needle. But the great work on the magnet, in those days, was written by Dr. Gilbert, of Colchester, in 1600. This author was the first to point out the magnetic properties of the earth, and to show that the earth, by its directive force, performed, relatively to the compass needle, the office of a real magnet.

There were several other writers on navigation in the

Elizabethan days, and their number is a proof of the eager desire that existed for information. England was then rich in princely merchant adventurers who sent forth expeditions of discovery in all directions. Enterprise was fostered and encouraged, and our naval worthies, in many instances, united scientific knowledge with their seamanship and their martial qualities. Having been well grounded and trained by careful study, they strove to improve the methods of observation, and to bring their practical experience to bear upon questions of navigation and nautical astronomy.

The most scientific sailor, during the reign of Elizabeth, was John Davis, the discoverer of the strait which bears his name. He improved the form for keeping logs, invented a new instrument known as Davis's Quadrant, and wrote a book of navigation called the "*Seaman's Secrets.*" He describes this treatise as "a collection of such practices as, in his several voyages, he had from experience collected." He had, in his youth, diligently studied the art, but he maintained that experience was also necessary. "It is not possible," he said, "that any man can be a skilful seaman but by painful and diligent practice with the assistance of arte, whereby the famous pilot may be esteemed worthy of his profession, as a member meete for the common weale."

It is worthy of remark that John Davis, and his contemporaries, made constant use of the globe, and the whole of the second part of the "*Seaman's Secrets*" is devoted to explanations of problems to be solved by the globe, "by which most excellent instrument," says Davis, "is performed all that is needfully required to the full perfection of all the three kindes of navigation." In another place he says that the "use of the globe is of so great ease, certainty and pleasure, as that the commendations thereof cannot sufficiently be expressed, for of all the instruments it is the most rare and excellent, whose conclusions are infallible—giving the true line, angle, and circular motion of any course on traverse that may in navigation happen." He then gives the solution of many problems by the use of the globe and compasses, especially for finding the pole's height or the latitude. Before the existence of tables of logarithms these methods were in general use, and they may even now be worked out with advantage by the student, as a means of acquiring a comprehensive grasp of the principles of spherical trigonometry.

John Davis and Abraham Kendall were famous, in their day, as scientific navigators; and not less celebrated, in the succeeding generation, was the famous Arctic pilot, William Baffin. The early history of Baffin is a blank, but the brief portion of his career that is known to us makes it impossible to suppose that he had not received a thorough training in the art of navigation. If he was entirely self-taught, his genius was most remarkable. When he is first introduced to us, off the coast of Greenland in 1612, he is actively engaged in an experimental observation for obtaining the longitude by moon's culmination. In 1613 he records an ingenious method of calculating the sun's refraction. The method of finding the longitude by a lunar observation was suggested by Werner in 1514, and again by Gemma Frisius in 1545; but William Baffin was the first observer who ever attempted to take and work out a lunar at sea, during his voyage to Hudson's Strait in 1615. He also recorded a great number of observations for latitude and variation of the compass, and a few for dip.

It is exceedingly instructive to read the journals of these old navigators, and to notice the interest they took in all questions relating to nautical astronomy, as well as the ingenuity displayed in planning out new methods of observing. This faculty must have been developed by previous study of works on the subject, and by instruction. In the practice of what they had learnt new ideas occurred to them, so that their daily observations were an ever-recurring source of intelligent interest; while in developing improvements in the details of work, they enjoyed the feeling that their matured experience and its results did good service to the science they loved, and was permanently useful to their country.

Davis and Baffin are the best types of these Elizabethan navigators; but they represent a class, and I am tempted to notice one more example of early instruction ripening into mature practice. I refer to a young lad named William Huntriss, a native of Scarborough, who is first met with in history as the servant of Captain James Hall, an officer who was employed by the King of Denmark to serve in expeditions to Greenland. Young Huntriss was loyally attached to his chief, and though quick and intelligent, he must also have been well grounded in the art of navigation. In the Greenland voyage of 1605 he went away in boats with Captain Hall, and was badly wounded by an Eskimo arrow. On his return he was so highly commended for his learning and skill as an observer, that the King of Denmark gave him a special allowance of £30 a year. When Hall left the Danish service, his faithful boy accompanied him, and went out in the Greenland voyage from Hull in 1612, of which Baffin was chief pilot and James Hall was general. On this occasion Captain Hall was killed by the Eskimo, and buried on one of the Knight Islands, off the Greenland coast. True and gallant and accomplished seamen stood around his grave, dug in a cleft of the granite rocks, surrounded by the stormy sea, with its dazzling icebergs. There stood Andrew Barker, the future Warden of the Hull Trinity House, William Baffin, the great discoverer, and the faithful young Huntriss mourning for his beloved master. The vacancy raised the Scarborough lad to the rank of captain, in which capacity he took the ship "*Heartsease*" home from Greenland, arriving safely in the Thames on the 19th of September, 1612. We then lose sight of young Huntriss, the skilful navigator and loyal friend. It is only a glimpse, but a very pleasant one. He was one out of a gallant generation of accomplished sailors, whose acquirements were due to the diligent labours of such men as Blundeville, Hood, Wright and Briggs, and to the importance attached to early training and instruction.

Richard Hakluyt, the father of English geography, was one of those who eloquently advocated the careful training and instructing of sailors and explorers. In the dedication of his great work, dated October, 1598, he pointed out how needful it was that, by way of lectures or such like instruction, seamen should receive a better education than had hitherto been the case. He referred to the courses of lectures for Spanish students, established by Charles V. at Seville; and mentioned the Guilds or Brotherhoods which Henry VIII. erected at Deptford, Hull, and Newcastle-on-Tyne, for the increase of knowledge in his seamen.

Owing mainly to the stimulating appeals of Hakluyt, public lectures in navigation and nautical astronomy were established, and supplemented no doubt by private instruction. Dr. Thomas Hood delivered lectures in the house of Sir Thomas Smith, in Gracechurch Street, and Edward Wright was lecturer on navigation for the newly-founded East India Company. We are also told by Mr. Howes, in his continuation of Stowe's Annals, that a lecture on geography, hydrography, and navigation was read in the chapel of Leadenhall. All this was in the time of Queen Elizabeth. Similar arrangements were continued in the subsequent reign, when there were navigation and geographical lectures given in the house of Adrianus Marius, in Blackfriars. Edmund Gunter, the inventor of the scale, also gave instruction at Gresham College; and some arrangements were set on foot by the Trinity House at Deptford for training officers and pilots.

We have independent and impartial testimony to the successful results of this admirable system of careful instruction from a contemporary Italian traveller. Pietro del Valle took a passage from Ormuz to Surat, in 1623, on board an English vessel, commanded by Captain Nicholas Woodcock, who had formerly served in the Arctic regions. The Italian noticed the use of Davis's cross-staff, and he not only praised the officers, but also the common sailors for their care and skill in navigation.

The bane of this country has always been the absence of continuity, especially as regards official work. It would appear that before the middle of the seventeenth century the navigation lectures had fallen into disuse; for Sir William Monson, writing in 1641, made a renewed appeal for the establishment of a lecture on navigation. The seamen had books, it was true; but the old admiral urged that books were not enough, and that verbal instruction was also necessary. He said that it had been questioned whether a man can attain to better knowledge by experience or by learning; but he very truly added that the man who has experience joined with learning becomes most excellent in the art he professes. What, he exclaims, made Abraham Kendall and John Davis so famous for navigation but their learning, which was confirmed by experience.

A quarter of a century after Sir William Monson wrote, Mr. Samuel Pepys was installed at the Admiralty, and a navigation school was founded. Charles II., in 1673, established a mathematical class, to be held within Christ's Hospital by a master skilled in mathematics and navigation, and to consist of forty boys taken out of the boys of the Hospital. At the age of sixteen those were to be apprenticed to captains of ships who, in the judgment of the Master of the

Trinity House, were sufficiently instructed in the art of navigation to be fit to enter on its practice. These apprentices received an outfit, and every year ten of them were provided with nineteen shillings a month for the first three years of their apprenticeship. The numbers of the navigation school, down to the present year, have been kept up to fifty or sixty boys. Ten leave every year, some entering the navy and others the merchant service. If they stay until the age of sixteen, these boys are able to work the examination papers for lieutenants in the navy.

So that the nautical school of Christ's Hospital has a continuous history extending over two centuries. From 1700 to 1750 as many as 128 of its boys entered the navy; from 1751 to 1800 the number was 105; from 1800 to 1850 there were 60; and from 1851 to 1877 there were 55. Admiral Bedford, the late Marine Adviser of the Board of Trade, was one of them. Admiral Sprott, the accomplished Surveyor, and now Conservator of the Mersey, is another. Commander Hull, R.N., the Arctic navigator and surveyor, who so long and so ably superintended the chart department of the Hydrographic Office at the Admiralty, also received his training at the Christ's Hospital Navigation School. So did another living surveyor of eminence, Lieut. L. Dawson, R.N., who now commands the "Investigator," a steamer belonging to the Indian Marine Survey Department.

The navigation school at Christ's Hospital is particularly interesting, because it was founded in those early days when the great importance of a thorough training was fully appreciated, and, alone among the kindred institutions of those times, it has continued to flourish.

The conclusion which we must draw from this brief and inadequate review of the labours of those worthies of the old time who studied and wrote and lectured for the instruction of English sailors and explorers is, I think, sufficiently evident. Throughout the period when England attained her greatest renown as a nation of intrepid discoverers, the period of Cabot and Willoughby, of Frobisher and Hudson, of Drake and Cavendish, of Davis and Baffin, the greatest importance was attached to a system of training and instruction. Numerous books on navigation were published, lectures were instituted, and pains were taken to furnish sailors and explorers with a thorough grounding in the art of fixing positions, laying down routes, and mapping.

Such was the policy of our ancestors; the results are recorded in history. This system formed a succession of generations of men who thoroughly understood the scientific branch of their profession. The experience of many of them led to valuable inventions and improvements in the art of navigation. To their skill and knowledge, based on early training, are due the memorable voyages and discoveries of which their descendants are justly proud. Thus we see cause and effect: on the one hand the lectures in Sir Thomas Smith's house and at Leadenhall, on the other the foundation of the East India Company and the voyages round the world.

In the last century the advance of scientific knowledge afforded increased facilities to the student of nautical astronomy. The foundation of Greenwich Observatory, the invention of Hadley's quadrant, the publication of the Nautical Almanac from 1767, were advantages which saved much laborious calculation and increased the accuracy of observations. A sense was also shown of the importance of early training by the foundation of navigation schools. One was attached to Greenwich Hospital, another was commenced by the Guild of Merchant Venturers at Bristol in 1738, and others by the Trinity House Corporations at Newcastle-upon-Tyne in 1712 and at Hull in 1785. But the last century is above all remarkable for the most illustrious instance of self-instruction to be met with, as

I hold, in the world's history. James Cook, the son of a day labourer who afterwards became the hind of a farm, was born at Marton in 1728. He learned writing and arithmetic at village schools, and at the age of thirteen was apprenticed to a haberdasher. At the age of fourteen he entered as apprentice in a collier brig, and continued to serve as a common sailor for ten years, at the end of which time he joined a man-of-war. We hear of no instruction after the boy left the village school at Ayton; yet within five years of his joining a man-of-war, James Cook was an officer conducting a scientific survey, and in eight years more he was selected to command an important expedition of discovery. The story of James Cook should be studied by every English boy; it cannot fail to incite many to emulate his great example. But self-taught men must always be the exception. That system of grounding and instruction which our ancestors, like the Spaniards and Dutch before them, believed to be so necessary, was one source of our maritime greatness and commercial wealth. Such at least was the opinion of our ancestors, and it can be shown that their opinion was justified by the results.

Yet if we take a survey of the provision which now exists in this country for such instruction, it would seem that the same importance is not attached to thorough training. When Mr. Cardwell consolidated and amended the Acts relating to Merchant Shipping in 1854, it was provided that examinations should be instituted for masters and mates to obtain certificates of competency. The Board of Trade laid down rules as to the conduct of the examinations; and at first it appears to have been felt that something more was needed, and that examinations alone would not supply the necessary training; for an attempt was made to start navigation schools in the principal seaports. Men were invited to qualify as masters, were examined for competency, and received certificates carrying with them a certain annual payment in addition to salary. The salaries were to be paid partly by the fees of the pupils and partly by a grant from the Treasury. Under these auspices, schools were actually opened in several seaports; but they broke down after a very short time, because the Treasury refused the money, and the Government abandoned its educational experiment in 1864. All the schools (except that at Hull) came to an end, or were only continued as places for preparing men for the examinations.

The Board of Trade Examinations alone do not furnish the means of supplying a training in navigation and nautical astronomy. Indeed, so far as I have been able to gather the opinions of leading commanders in the mercantile marine and of examiners, they simply encourage cramming. I am told that the candidates rarely care to know more than will barely suffice to pull them through the examinations, and that the knowledge thus acquired (slight to begin with) is extremely evanescent—so much so that, in many instances, a week after a candidate has passed he could not again successfully undergo the same ordeal. I read also, in a recent very useful work, by an eminent commander of the port of Liverpool,* that many young men have absolutely no groundwork of education, and pass the examinations merely by dint of hard cramming. This being the case, the Board of Trade Examinations, without schools, scarcely meet the requirements of the case.

Ten years after the institution of the Board of Trade Examinations, the Science and Art Department at South Kensington began to examine in navigation and nautical astronomy in 1864, with a view to giving a stimulus to the teaching of these useful branches of knowledge. So far as they go, these examinations must have done unmixed good, but in the absence of schools their influence is necessarily limited. From 1868 to 1881 the average number of candidates for the navigation was 290, and for the nautical astronomy examination, 80. Last year (1881) there were 338 for the former and 66 for the latter. But the greater number come from one place, namely, Hull. There are a few from Greenwich, Yarmouth, and the science school at Gosport, occasionally one from Plymouth, and stray candidates from other places.

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* "*Wrinkles in Practical Navigation,*" by Captain Lecky.

So that Great Britain is deplorably deficient in schools for giving a thorough grounding in the subjects, a mastery of which is necessary for a navigator or an explorer by land. The principal one is at Hull, in connection with the old Trinity House, which was founded in 1785, and re-organised under the direction of Dr. Lyon Playfair in 1855. It was founded with two objects—to supply a practical education for boys, and to increase the knowledge of adults. From 150 to 160 boys are at the school, who are clothed at the expense of the Corporation, and two-thirds are wholly exempted from tuition fees. The course of instruction embraces mathematics, navigation, nautical astronomy, magnetism of iron ships, use of instruments, chart drawing, and use of charts. The Hull boys have obtained fifty of the Queen's medals awarded by the Science and Art Department for navigation and nautical astronomy, since 1868, and in 1881 there were as many as 38 candidates from the Hull Navigation School for the nautical astronomy examination at South Kensington, out of a total of 66, and of the 38 as many as 28 were successful. This school seems to be thoroughly efficient, and is the only one on the same scale in Great Britain.

At the Greenwich Hospital School about 62 boys are taught navigation and nautical astronomy, and the honours lists at South Kensington show the teaching to have been very successful. Navigation and nautical astronomy are also taught in the nautical school at Christ's Hospital, and on board the "Worcester" and "Conway," where excellent instruction is given to 160 young gentlemen in each of those ships. At Gosport there is a school of science, commenced in 1873, where the number of students, in navigation and astronomy, averages from three to fifteen, at ages from thirteen to nineteen. This school has also been successful at South Kensington. The master reports, however, that few mercantile seamen join the classes, because "rule-of-thumb methods are entirely ignored." At Yarmouth there is also a class of about twenty boys. At the excellent navigation school, established in 1862, and conducted by Mr. Merrifield, at Plymouth, the principal work is preparation for the examinations; but two evenings every week are devoted to classes where a course is given of plane and spherical trigonometry, the use of instruments, and method of fixing the position of the school by observation. An endeavour is also made to give those who attend some knowledge of natural phenomena. The average attendance at these evening classes is about twenty, mostly young lads. At South Shields there are some good navigation schools, and there are able and experienced teachers in London, and at Liverpool, Sunderland, Leith, Dundee and Aberdeen, but they are all mainly employed in preparing adults for the examinations.

At Bristol the class for teaching navigation, which was founded by the Guild of Merchant Venturers in 1738, was recently given up, on the ground that scarcely any pupils attended, and a navigation class was substituted at the Trade School, which is supported by the Guild. But this was also discontinued in 1879, and there is now no provision at all for the thorough instruction of sailors and explorers in Bristol. At Liverpool there are, I am informed, at least five private establishments for preparing candidates for the Board of Trade Examinations, and some excellent teachers, but there are few students who study the subjects thoroughly. The navigation classes which were opened from 1874 to 1879, in connection with the Science and Art Department, under the management of the Liverpool School of Science, have been given up, owing to the want of pupils. Glasgow and Greenock are as destitute as Liverpool.

Navigation is taught, to some extent, in a few other places, as shown by the South Kensington Reports. But there is no system in this country for supplying instruction to sailors and explorers—the instruction that was considered to be so necessary in olden times. There is no endowed navigation school for thoroughly training young lads belonging to the poorer classes at London, Liverpool, Bristol, Glasgow, or at any of the great seaports except Hull. Such training was deemed essential to the prosperity of Spain in the height of her power, of Holland when she sent forth her expeditions of discovery, of England in the days of Elizabeth and the first Stuarts. Nor is it neglected in neighbouring countries.

In France, for example, liberal and effective means of education are provided for the seafaring classes. An Instructor, paid by the Government, resides in each of the principal seaports, and affords instruction free of charge to all seamen who desire it.

In Holland there is a great navigation school at Amsterdam—"*de Kweekschool voor de Zeevaart*"—which was founded in 1780. Here about fifty boys are clothed, fed and boarded for a hundred guilders (£10) a year. There are also ten other navigation schools in Holland, where, by the latest report, 440 students received instruction. When we consider that the population of Holland is 4,000,000, and of Great Britain 30,000,000, we may form some idea of the difference between the two countries in their appreciation of the importance of supplying instruction to their sailors.

REPORT OF

SCIENCE AND ART DEPARTMENT, S. KENSINGTON.

Places.	Number of Pupils.				Payments to teachers on results of Examinations.		Passed S. Kensingt'n Examination in 1881.		Totals.
	1880.		1881.						
	Nav	N. A.	Nav.	N. A.	Nav.	N. A.	Nav.	N. A.	
					£	£			
Hull (Navigation School)..	91	57	70	55	53	44	45	28	1881. Pupils in England and Wales in
Plymouth (5 Schools) ..	75	5	97	4	30		24	1	
Yarmouth (Sch. of Science) ...	40	10	30	30	7		6	3	Navigtn.. 261 Naut. Ast. 137 398
Shields	16		8		4		8		Scotland:
Barrow-in-Furness..	20		12		6		7		152 at Leith 20 at Glasgow
Rochester	12						5		
Swansea	10		6	5	5		5		
Gosport	8	8	8	8	2	2	6	6	1881. Honours at S. Kensington.
Manchester....			6	6			4	3	*1st class Navigation:* Greenwich..1
Boston	3		5				1		*2nd class Navigation:*
Falmouth......	6		5		4				Greenwich..4
Truro			4				1		Truro......1
Sunderland....	10				7				*2nd class N. A.:*
St. Helens	20				13				Greenwich..2 Plymouth ..1
Milford Haven									
Southampton ..	10						1		

Belgium has only two important seaports, Antwerp and Ostend, but at both there are large and carefully-regulated navigation schools, with gratuitous instruction. In Germany there are large navigation schools at Hamburg, Bremen, and other ports.

The system of education in Denmark, as regards navigation and nautical astronomy, is just as complete. There are five navigation schools to a population of under 2,000,000, each receiving about £170 a year to provide instruments and apparatus useful for teaching. Examinations are held periodically at one or other of these schools, and lads pass after studying for one or two years, according to their ability and previous training. They learn arithmetic, the use of logarithms, geometry, trigonometry, the use of the compass and of charts, of the sextant and its adjustments, tides and the movements of heavenly bodies, variation by azimuth and amplitude, and the methods of finding latitude and longitude. The candidate must also understand great circle sailing, deviation of the compass, the construction of charts and instruments, ocean routes and the influence of winds and currents, and meteorology. He must be fifteen years of age. Every candidate who passes an examination receives a sum equal to £2 15s. if his home is at the place where the examination is held, and £5 10s. if he has come from a distance. His payments at the school amount to £1 2s. a month, and £1 8s. for board and lodging. There is a similar system in Sweden and Norway.

Even in the little province of Biscay, in Spain, the Basques have established no less than four navigation schools along its coasts, at the small towns of Lequeitio, Bermeo, Plencia, and Santurce. The first and last were founded and endowed through the liberality of wealthy individuals, but the two others were set on foot by the towns themselves. The school at Santurce, particularly, is conducted by a capable master, and is well supplied with instruments, charts, and books. It struck me, in visiting this coast last August, that, considering their means and the size of their little province, with a population under 200,000 souls, these Basques were doing more than has yet been undertaken by this great and rich country of ours, and that they were setting an example which we should do well to follow.

In modern England alone is the training of those whose avocations take them to distant regions by sea or land, in the knowledge which is necessary to them, comparatively neglected. Yet of all people in the world, the English need such knowledge most. Large numbers of Englishmen visit countries which have never been geographically described or correctly mapped, and traverse routes along which no observations have ever been taken. Many more annually pass and repass over tracts respecting which some previous contributions have been recorded, but which need additional and more correct observations before they can be adequately described and mapped. Every year these wanderers, in various professions, and engaged upon diverse avocations, spread themselves over every quarter of the globe. Yet, for want of necessary training, they travel and return without any or with few results that can be utilised for geographical purposes. There are officers in the army and navy, clerks and others employed in merchants' houses, planters and settlers, engineers, missionaries, consular agents, collectors, sportsmen, and ordinary travellers wandering over all parts of the earth.

It seemed so discreditable that our travellers and explorers, from want of instruction, should so constantly fail to produce any tangible results from their journeys, that the Council of the Royal Geographical Society resolved to attempt the application of at least a partial remedy. It was believed that in many instances such travellers would gladly and even zealously add the work of observing and collecting geographical information to the more direct objects of their journeys. It was thought that nearly all would do so if they were made sensible of the value of such work, and if the means of acquiring the necessary training were within their reach. The Council determined to provide this preliminary training for all who desired to receive it.

Mr. Coles, the Curator of the Society's Maps, was appointed to give instruction in practical astronomy, route surveying, and mapping; and at the same time a small observatory was constructed on the roof of the Society's house. In 1879 Mr. Coles began to impart this instruction, and he has given 532 lessons to 42 students, down to the end of 1881. The subjects taught embrace nearly all the problems in practical astronomy and surveying, the use of the theodolite, sextant, and artificial horizon, manner of plotting a traverse survey by means of the prismatic compass, and map construction. The students have included civil engineers, sailors, soldiers, surgeons, magistrates, botanists, missionaries, and one bishop. Half the small fee is paid by the student and half by the Society. The measure has answered perfectly, and is likely to be still more successful in the future.

When we reflect that upwards of 40,000,000 tons of British shipping are annually cleared and entered at our seaports, it will readily be admitted that the training of our sailors is at least as important a matter as the instruction of our travellers and explorers by land.

But the instruction offered by the Geographical Society can only be taken advantage of by a small fraction of those whose occupations take them to distant and little known regions, and who, if they had the needful training, might do good service to their country. It is desirable that all such travellers and settlers, and all young sailors, should have had similar advantages. This end can be secured by furnishing the means of acquiring the necessary knowledge to boys and young men before they enter upon their professions and callings. If it was a general practice to teach applied mathematics and practical astronomy, with surveying and mapping, in schools, such knowledge would be instructive and useful to all boys, while a certain number would find it to be a great advantage, and would, through the training thus received, do good service to geographical science in after life.

It is also most important that lads intended for a sea life should all receive a thorough grounding in plane and spherical trigonometry, and go through a course of navigation and nautical astronomy before or soon after entering; and that this system should be substituted for the existing baneful cramming for the superficial Board of Trade Examinations. Surely the great seaports of this wealthy and powerful country should establish navigation schools on at least as broad and comprehensive a basis as has been done in every other maritime nation of the civilised world.

The two things needful are to increase the means of instruction, and to substitute a firm foundation of knowledge for the parrot teaching by rule of thumb. Former generations believed such thorough training to be necessary for the safety of their ships and the prosperity of their commerce. All civilised maritime countries, except England, have shown their full concurrence in the belief of their ancestors by establishing adequate navigation schools and efficient teaching. Many of the instructed and thoughtful seamen of our own land are conscious of the evil consequence of the present absence of any system here. It is because the case for improvement is so strong, because all former experience points to the expediency of making suitable provision for that improvement, and because I have personally been in positions to see and feel the urgency of what I have represented as needful, that I have ventured to address the Institute on this subject. I would submit in conclusion that if the point for which I contend is held to be established, the consideration of measures for securing the end in view may safely be left to others who, both here and elsewhere, possess that administrative knowledge and educational experience to which I can lay no claim. If the want is admitted and felt, there will, I am confident, be no difficulty in finding the remedy.

SOME POPULAR MISCONCEPTIONS OF DARWINISM.

By REV. S. FLETCHER WILLIAMS.

Of the words spoken during the last quarter of a century none has produced more violent agitation, none has been more bitterly opposed, none has been subjected to more silly abuse, none has gone more rapidly towards conquest, none has produced a wider change in human thinking, than the word "Darwinism." It is only twenty-two years since the *Origin of Species* was published, and already the philosophy of that book has conquered the great intellectual centres in the old world and the new. Its author has kept the honours of the discussion; and why? Because behind the power of the book is the power of the man. Mr. Darwin is now everywhere recognised as an earnest man of transcendent scientific knowledge, with a love of truth for the truth's sake that is as fascinating as the breadth and thoroughness of his learning, with a temper the balance of which is one of the sources of his strength. He is no mere iconoclast, a vandal, a speculative adventurer; but a self-poised apostle of science, distinguished for a patient industry that rebukes the haste with which we rush to conclusions, and for a dignity of candour that puts all dogmatism to shame. His veracity, his fairness, his cautiousness of method are so evident, his willingness to re-consider his positions is so marked, his modesty is so sincere, as to disarm all but the most determined prepossession. Nevertheless, the philosophy so attractively presented, and so widely accepted by students and interpreters of the laws of life, is still hotly opposed in many quarters, and the opposition is often based upon misconceptions of what Darwin and his fellow-teachers claim.

It is worth while, then, to examine some of these misconceptions, and to show wherein I think they are misconceptions.

What is Darwinism? The earth is covered by numberless clusters of organised beings—men, birds, beasts, fishes, and plants. Very loosely speaking, we may say that each cluster of which the individuals reproduce other individuals having the common characteristics of the cluster is called a species. The question is how these streams of life, which, though in some cases intimately connected, seem now permanently severed one from the other, first came into existence.

Previously to the appearance of the *Origin of Species* the majority of naturalists and religious persons had—to put the statement guardedly—maintained that no evidence had been adduced to prove that species in the animal world had descended from other species by ordinary generation; since the publication of the *Origin of Species* a continually increasing majority of naturalists and a number of the most formative minds in theology have believed that evidence has been brought forward, sufficient in nature and in amount, to prove that proposition. In other words, the old theory was that each species was created separately—that, for example, each species of thrush, of finch, of shark, of tiger, of grass, of reed, of fungus was called into existence by a distinct creative fiat. The new theory is that every existent form of life has been evolved from some other, that all the thrushes had a common ancestor, all the families of birds one still more remote, all the vertebrate animals one removed still further into the dark backward and abysm of time. I am not, at present, expressing an opinion as to which of these theories is the correct one. My object is to state distinctly what the Darwinian theory is, and what the revolution in scientific opinion which Mr. Darwin has effected amounts to. How many comprehend this? Mr. Ruskin, for example, one of the most acute of men and a great reader of natural history, speaks, in his *Queen of the Air*, as if Darwinians held that a bird could develop from a fish. The bird is separated from the fish by the entire family of reptiles, and a Darwinian feels, more intensely than a naturalist of any other school can feel, that the overleaping of this enormous gap is an impossibility in the nature of things. He does not recognise, throughout the vast series, one instance of "overleaping." He maintains that the evolution took place by means of infinite gradations and countless variations, each so minute as to be hardly observable. His real difficulty is not to account for such differences as those between a salmon and an elephant—a difficulty which no one whose knowledge of science exceeds that of a popular jester or an *Athenæum* reviewer would propose—but to find explicit proof that any one well-defined species, such as the missel-thrush, sprang by ordinary generation and natural selection from any closely-allied species, such as the common thrush or blackbird. This difficulty is well and honestly put by Professor Huxley. "After much consideration," he writes—at least he wrote this eleven years ago, and I am not aware that he has retracted it—"After much consideration, and with assuredly no bias against Mr. Darwin's views, it is our clear conviction that, as the evidence stands, it is not absolutely proven that a group of animals, having all the characteristics exhibited by species, has ever been originated by selection, whether artificial or natural. Groups having the morphological character of species, distinct and permanent races, in fact, have been so produced over and over again; but there is no positive evidence, at present, that any group of animals has, by variation and selective breeding, given rise to another group which was even in the least degree infertile from the first. Mr. Darwin is perfectly aware of this weak point, and brings forward a multitude of ingenious and important arguments to diminish the force of the objection. We admit the value of these arguments to their fullest extent—nay, we will go so far as to express our belief that experiments conducted by a skilful physiologist would very probably obtain the desired production of mutually more or less infertile breeds from a common stock, in a comparatively few years; but still, as the case stands at present, this 'little rift within the lute' is not to be disguised nor overlooked."[1] Mr. Alfred Russell Wallace has mentioned some facts which bear directly on this difficulty. In certain districts lying widely apart from each other in South America he found butterflies which, though closely-allied species, had the characteristic specified by Professor Huxley, that they were mutually infertile. But in the districts between their respective localities there were several varieties intermediate between these two, and with these the species at, so to speak, each end of the line, were fertile. Under these circumstances it is easy to see that two species, which mutually repelled each other and were infertile, might be connected by ties of relationship through varieties intermediate between them. The passage I have quoted from Professor Huxley, and this illustration from Mr. Wallace, enable us to realise how exquisitely slight is the dividing line across which sound Darwinians believe it to be possible for one species to pass into another.

1. Mr. Darwin maintains that this barrier has been passed in a continuous series for millions of years, and that thus the countless varieties of the animal world have arisen. Yet, notwithstanding the array of evidence in favour of this conclusion, there is a prevalent misconception that Darwinism is a mere dream, an idle fancy, a baseless speculation, having no facts in its favour. But the facts which point

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[1] *Lay Sermons, Addresses, and Reviews.* By T. H. Huxley, 1870. p. 323-4.

towards Darwinism are numerous and significant. Students in natural history had observed these facts long before Mr. Darwin's day, and had to some extent formed theories to account for them. It was the existence of these facts in botany and zoology that first led Mr. Darwin to his famous theory.[2]

It is hardly possible to put into a brief paper arguments which shall be deemed decisive in favour of the general doctrine of Darwinism; the force of the appeal which the process of reasoning makes depends so largely upon a somewhat wide acquaintance with the facts of natural history and geology, and upon the habit of mind which is formed by the constant recognition of facts which tend with more or less of directness to the same conclusion. Two or three lines of the argument may, however, be indicated.

There is, first of all, the discovery which every student of botany or zoology is continually making, that forms which his manuals teach him to regard as specifically distinct are linked together by varieties which he cannot rank with confidence in this or that class, but which rather seem as stepping-stones between classes. The first idea suggested to him is that of a "rectification of boundaries;" the increase or the diminution of species so that his varieties may find their proper resting-place. The study of teratology may for a time confirm him in this belief. He finds, for instance, that variations within species may be produced by an excess or by a lack of nourishment; and that when the conditions are equalised the varieties disappear. But there are variations which refuse to vanish; there is a law of persistence of type which frequently comes into operation here. Gardeners are aware of "sports" in vegetation. One branch of a rose or of a fruit-tree will produce different flowers or fruits from the rest, and buds taken from this branch will keep the character of the "sport" under different conditions of culture, and the "sport" may become the parent of a new variety. The *Saxifraga cernua* is thought by some botanists to be only a variety of the meadow saxifrage; but it clings to its Alpine home, and maintains its characteristics there. It refuses to be cultivated back again into *Saxifraga granulata*. Let the young student, then, conceive of an accumulation of various conditions, all working in one and the same direction. His knowledge that if there are varieties that tend to revert to a common form, there are also types that are persistent, forms that will keep the variation and die in altered conditions rather than revert, will prepare him to welcome in the Darwinian doctrine of the evolution of species a plausible solution of his problem.

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[2] But the theory of natural selection was first announced by Lamarck, in the year of Mr. Darwin's birth, in 1809; while Leopold Von Buch, in 1825, Geoffrey St. Hilaire and Von Baer in 1828, Oken in 1842, Mr. Herbert Spencer in 1852, and Mr. Alfred Russell Wallace in 1858, are the more prominent thinkers among many who had discussed natural selection in plants and animals since Lamarck announced the idea, and before Mr. Darwin published the *Origin of Species*.

The possibility of accumulating variations in a given direction is a fact familiar to the agriculturist. The whole art of cultivation and the skill of the breeder depend upon it. The ferns, flowers, and fruits of our gardens, so far as these have been improved by culture, have been improved in this way. In this way have come the race-horse and the Leicestershire sheep. There is a power in nature by which some variations are perpetuated and accumulated, and others are dropped. For since every variation, however slight, and whatever function it affects, is either an advantage or a disadvantage to its possessor; in the struggle for existence arising from the fact that all living forms multiply faster than their means of subsistence, the favoured individuals will survive, while the others will die out. This is the theory of natural selection. The struggle for existence tends constantly to exaggerate any slight advantage an individual may have over its fellows; and the accumulation of variations is still further aided in the case of animals by the law of sexual selection, the preference which the females show for those males in which certain qualities are predominant.

The study of palæontology extends immensely the scope of this argument. It supplies links between species and genera the existing forms of which are widely separated, and as in the exposition of the pedigree of the horse, for instance, which is the subject of one of Professor Huxley's popular lectures, it marks the different stages in the development of particular organs. The geological record, both in the hints it furnishes and in the imperfection of its testimony, may be compared to the ruins of castles and cathedrals which supply data for the conclusions of the archæologist. One pretty complete ruin gives the architect confidence in his interpretation of many scattered fragments; and when fossil remains are found linking together two or three genera, the palæontologist is aided in his reconstruction of the whole order.

The existence of rudimentary or aborted organs is another strong argument in favour of the doctrine of evolution. Rudimentary legs, for instance, are found under the skin of many snakes; manifestly of no use to them, but intelligible if we may suppose that snakes have descended from walking reptiles. This is but one illustration from a multitude that might be quoted from all departments of life; and their application to the argument depends on our belief that nature cannot lie. These organs must at some time or other have been of use; they are like the characteristic ornaments of Doric architecture, giving us a history of the development from wooden to stone structures. Some philosophers have affirmed that these organs serve to indicate the development of the idea; that though they are of no use to the creature, they serve to mark out the place of the creature in the scale of being; that there is no actual relation of descent among living forms, but that they all stand in a certain relative position in the classification of creation. But, to say the least, it can be no more unworthy of the Creator to work out an actual scheme of development than gradually to evolve it in thought. Let the plan of creation as existing ideally be only conceived of as translated into actual facts, and the doctrine of evolution appears.

A question is frequently asked by those who would affirm an indefinite variability within specific limits rather than the evolution of species—whether these variations are not confined to the superficial phenomena of life, whether they extend to all organs and functions. Unless they do so, it is said, unless every vital function is variable, the argument fails. Pigeons, for instance, and dogs are very variable, but it would be false classification to make new species according to the number of tail-feathers, the size of the beak, or the bulk of the dog's body and the character of his clothing. This is the crucial point of the Darwinian doctrine of evolution; and it may be answered by pointing out such a case as that of the Australian Marsupialia, where so important a function as the reproductive one is a peculiar continental characteristic of almost all the mammals. Mr. George St. Clair, in his work on *Darwinism and Design*, suggests another answer to the inquiry. He adopts the teachings of Mr. Herbert Spencer, and points out that every organ, those of nutrition and generation, as well as the limbs and organs of the senses, are adjusted by chemical and physical action.[8] A change in the surroundings must bring about a corresponding change in the economy of the creature, or the creature will perish; and this is a law of universal sweep, affecting what appear to be the deeper and more essential, as well as those which appear to be the incidental, marks of a species.

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[8] *Darwinism and Design*, 1873, pp. 93–96.

A broad objection to the Darwinian doctrine of creation by evolution, and a leading proof of successive and separate creations, is that emphasised by Agassiz—the unity of type within the grand divisions of the animal world.[4] All Radiates (star-fishes and their kindred), all Mollusks (snails, terrestrial, lacustrine, and marine), all Articulata (insects of every kind, crabs, lobsters, &c.), and all Vertebrates (beasts, birds, reptiles, and fishes), show but what may be called the family type. No one type ever passes into another. No star-fish ever becomes a snail, no butterfly ever becomes a bird. This is certainly a very important argument. I am not aware that Darwinians can meet it by adducing transition forms through which, say, the mollusk passed into the fish, or the star-fish into the crab. But, in the first place, Darwinians allege that they have but begun the application of their principle to animated nature;[5] in the second place, Professor Haeckel has put his finger upon a form of inferior life, which, in his opinion, furnishes the ground-plan for the development of the Vertebrata; and, in the third place, it is not necessary to the logic of Darwinism that there *was* development of any one of these four grand types out of the other—Darwin's own words being that all existing varieties of animal have been developed in the course of nature from "*at most* only four or five progenitors."[6] Haeckel thinks he has found the thread of matter in which nature first laid down the vertebral column which has been moulded into the skeleton of bird and beast. Professor Huxley says that this contribution to human knowledge by Haeckel is of the kind which takes away one's breath.[7] But the Darwinian is not forced to build upon Haeckel's foundation. Enough for him to say that the tree of life may have four great branches—the four types of Agassiz—which have been quite distinct since the remote epoch at which they branched from some form of life more ancient than any of the four; for, as Darwin says, it is not incredible that "all the organic beings which have ever lived on this earth may be descended from some one primordial form."[8] Agassiz eloquently demonstrates that all living beings whatever originate in a single form—the egg. The Darwinian may perfectly well hold that the four distinct types mentioned by Agassiz may have been four sprouts from one seed, four chickens from one egg, each of which subsequently developed in its own way. I confess that, if it is not presumption in me to express an opinion, this answer to Agassiz seems to me the most satisfactory; and one chief reason for holding it is that it seems to accord best with the embryological argument.

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[4] See *New York Tribune Lecture Extra*, No. 8. "The Method of Creation." Twelve Lectures by Professor Louis Agassiz.

[5] Darwinians reply that the geological record is so imperfect—that we have so few fossils from out of the vast mass of ancient life—and that we at present know so little concerning the fulness of life in geological epochs, that all conclusions drawn from what we now discover must be insufficient. There may have been numerous transitional forms, though we have not found them. Of the many volumes of palæontological history we have but the last volume, and even that in an imperfect state.

[6] *Origin of Species*, 5th edition, 1869, p. 572.

This argument appears to me to be against Agassiz. "There is a time," thus he states the doctrine, "when the human embryo is so like the fish embryo that it is hard to say what is specifically human and what is specifically fish; later it may be compared to the reptile and the bird; and its own characteristics are superimposed upon those which it has in common with the lower representations of the type."[9] Fairly consider this fact. A mammal passes, before birth, through the forms of fish, reptile, bird. Does not such a fact inevitably *suggest* to the human mind that there has been some vital connection between beast, bird, reptile, and fish? May we not reverently say that if the Almighty created the mammal in one moment, perfect, it does not, according to human ideas of wisdom or plan, seem likely that He would, as it were, enclose in the perfect mammal imperfect models of bird, reptile, and fish. A consummate human artist does not put the moulds of former images into new statues. If, at a certain point in time, obediently to the law of creation, the fish passed into the reptile, the reptile into the bird, and the bird into the mammal, then the embryotic stages would be simple traces of remote relationship.[10] We should thus discover also the reason why, as Agassiz alleges, the embryotic development of the Vertebrates does not pass into the Mollusks, the Articulates, or the Radiates. The mammal passes before birth through the forms of bird, reptile, and fish; but at no stage in the development of the embryo is there any resemblance to an insect or star-fish. The answer is that the four grand types developed from a common root; that, after separating, they never mingled or could mingle; and that the mammalian embryo is never even remotely like a Radiate, for the simple reason that none of the mammal's ancestors was a star-fish. The same reason which accounts for embryotic resemblance *within* the type accounts for its absence *beyond* the type. And if we find that between classes, externally so unlike as the reptile and the bird, wonderful "missing links" of connection have turned up, two reptilian birds, the Archæopteryx and the Ichthyornis, and a bird-like reptile, the Campsognathus, must we not go the length of admitting that the vertebrate kingdom bears upon itself evidence of a nature which, when rightly understood, almost compels the human mind to believe that it was created by evolution? When we go one step further, and realise the significance of the fact, that there are in the highest vertebrate animals parts of the framework which are useless to their present possessors, but which were useful to their predecessors in evolution, we shall find greatly strengthened all previous arguments to prove that the scheme of creation has been that of evolution.

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[7] *Critiques and Addresses.* By T. H. Huxley, 1873, p. 315.

[8] *Origin of Species*, 5th edition, 1869, p. 573.

[9] *New York Tribune Lecture Extra*, No. 8, p. 6, 2nd col.

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[10] The subject is discussed in Haeckel's "Natürliche Schöpfungsgeschichte," xi Vortrag, and *Anthropogenie*, xiii-xix Vorträge; A. Kölliker, "Entwickelungsgeschichte des Menschen u. der höheren Thiere," 2nd ed., Leipzig, 1876; F. M. Balfour, *A Treatise on Comparative Embryology*, London, 1880. A general synopsis in A. S. Packard's *Life-histories of Animals, including Man*, New York, 1876; and a particular Account of the History of the Chick, in M. Foster and F. M. Balfour, *The Elements of Embryology*, Part I.

In thus tracing the lines of the argument for Darwinism, I have said enough to show what a misconception it is that it has no facts in its favour. The facts are so abundant that the idea to which they point has taken a profound hold both of the scientific and philosophic speculation of our time. I do not say, nay, not any scientific authority would say, that Mr. Darwin's theory of the facts is a finality. It may be included in some higher law, as, in truth, advocates of the evolution doctrine claim that it is already included. Mr. Darwin himself supplies the storehouse out of which the facts for other theories are gathered, and in his later works recognises, with his superb candour, that to the law of natural selection must be added other laws of variation to account for the origination of species.[11] But while Mr. Darwin's explanation of the facts may be thus absorbed, it can never be superseded; it can never be set aside, any more than the facts of gravitation can be set aside by a wider knowledge of physical force. As the moon will still fall through so many feet in a second, so species will ever tend to arise from natural selection, upon whatever improved theory of the controlling law. One of the wisest remarks in Whewell's writings has always seemed to me this: he says of the progress of the sciences:—"The earlier truths are not expelled, but absorbed; not contradicted, but extended; and the history of each science, which may thus appear like a succession of revolutions, is, in reality, a series of developments. . . . Real truths, when once established, remain to the end of time a part of the mental treasure of man."

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[11] For the modification of Mr. Darwin's original views on the extent of the influence of the principle of Natural Selection, see *Descent of Man*, 2nd edition, 1874, p. 61.

2. So far I have employed the term Darwinism in its strict scientific sense. Using it now and henceforth in its popular sense as synonymous with evolution, I proceed to say that the next great misconception is that Darwinism attempts to account for the origin of life. It is assumed that at some period of the past there was no life, but only what is termed dead matter, and an attempt to reveal the beginning of life is attributed to Mr. Darwin. But he, and most of those who labour in the same field, make no attempt to discover the first quickening of the world. He assumes life as already in existence, life of a simple kind, but still life. Simple life? Nay. Life containing the potentiality of all its products—life, out of which, by the influences of climate, air, water, temperature, food, enemies, friends, have come the multiplied forms of plant and animal that fill earth and sea and sky. He begins with life already in existence. Thus far the human intellect has found the origin of life an insoluble mystery, and Mr. Darwin does not profess to penetrate this mystery. So, too, Professor Tyndall writes that the evolution hypothesis "does not solve—does not profess to solve—the ultimate mystery of this universe. It leaves, in fact, that mystery untouched."[12]

Evolutionists are among the first to confess that there is, and ever will be, a definite line of demarcation between that which is knowable and that which is unknowable, something which man cannot reach, but which, nevertheless, thoughtful men will ever strive to reach. Scientific investigators may be compared to a group of travellers who are starting for some central point, and pursuing their course on radiating lines which diverge from the common centre. Some will succeed in wandering further from their point of departure than others, but sooner or later each one is brought face to face with a huge dark veil, beyond which he cannot go—a veil of impenetrable darkness, intangible, invisible, but which refuses to allow him to pass any further. He seems to reach the point where the finite and the infinite meet. At that point he ceases to converse with all these material structures and existences. He may meditate on the wondrous properties with which the varied forms of existence are endowed, and meditate beneficially, to the end of time; he may spend his whole life in contemplating the external and sensible phenomena with which he stands face to face, but he can gaze only upon effects whose cause is hidden in a glory that is inaccessible—a glory that is dark amid the blaze of noon, and that blinds his eyes with its unsearchable splendour. When he searches for the internal, mysterious cause he appeals to Nature, and says: "Whence do these existences come, and when and how were they so wondrously endowed?" Nature gives him no response; but her very silence, so impressive, so suggestive of reverential awe, seems to become vocal, and to say to him in solemn tones, "Take thy shoes from off thy feet, for the place whereon thou standest is holy ground."

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[12] *Discourse* on "Scientific Use of the Imagination," at British Association, Liverpool, September 16th, 1870, reprinted in *Fragments of Science*, 6th edition, 1879, vol. 2, p. 134.

3. Another misconception is that Darwin, and evolutionists generally, teach that man is necessarily swinish, low in organisation, in mental powers, and in moral character. Because evolutionists teach that man's physical organisation has come to him by the modification of some lower form, it

is inferred that they inculcate that man himself is but animalish. Then this inference of the critic is asserted to be the fact, and Darwin is charged with affirming that man is only a little more advanced than a brute.

In answering such a misconception we should remember, in the first place, that the wisdom which has produced the universe, including man, has, beyond all question, pursued the best possible methods. If our study of nature should lead us to the conviction that some of these methods are different from what we had supposed, we should rather conclude that our former conception was low and crude, than that God has pursued low and crude methods. The only reverent attitude for man is that of a learner, not that of a judge, and still less that of a censor. It is, as a disciple, to ask, What is the fact? What is the method which has been pursued? This is a question of science; and if once man ascertains the fact and the method beyond all doubt, or if once he learns them as nearly as possible, then the notion that he may find it his duty not to believe what he has ascertained is obviously equivalent to the blasphemous proposition that God has made mankind one way, and exacts it as an obligation from intelligent beings to believe that He made it in another. Whatever may have been the method by which man has come into existence, we must admit that such method is the best possible one, or else affirm, in substance, that God is either imperfect or malicious for not pursuing the best course.

To the consistent evolutionist two courses are open. He may say that man's physical body, and to a certain extent his mental powers, are derived from an animal lower in the scale than man, but not necessarily from a monkey. It is not at all essential for the evolutionist to believe that man is a descendant of the gorilla. He may rather say that both man and gorilla are the descendants with modifications of some animal that preceded both. A botanist is not compelled to believe that the Early Rose potatoe is a descendant of the Peach-blow, nor that the Peach-blow is a descendant of the Early Rose. He may consistently believe that both Peach-blow and Early Rose are descendants of a common ancestor. So an evolutionist may decline to affirm that the ape is derived from man, or that man is derived from the ape. He may consistently affirm that both are derived from a common ancestor.

The opposition to the Darwinian view of the origin of man comes largely from those who affirm that it brands him with the indignity of an ignoble genesis. They launch their keenest wit, their fiercest sarcasm, and their strongest denunciations against those evolutionists who believe that man came into existence by modification from the monkey. These satirists were joined by Mr. Froude when, in his address at St. Andrew's University, he described Mr. Darwin as a philosopher who is looking gravely to the courtship of moths and butterflies to solve the problem of the origin of man, and prove his descent from an African baboon. Their notion was racily put by *Punch* in the famous witticism: "Darwin's definition of man—a perfect beast."

Let us look the position straight in the face. Is there necessarily anything debasing in the belief of those who think that man has proceeded from the monkey? I presume that those who cannot contemplate a chimpanzee as their ancestor with equanimity, or without a gibe, generally affirm that man was instantaneously created from a mass of dust. There was not a man on earth, not a man having ever been on earth, when suddenly, in an instant, where there were simply the bare ground and the blank air, there sprang into life a full-grown man, complete in all the parts of manhood. The instantaneous-creationist thus gets man from a mass of inorganic dust. The evolutionist gets him from a highly-organised animal, possessed of most wonderful endowments in the way of bone and muscle, digestive, respiratory, circulatory, and nervous systems. Which now gives to him the nobler origin? Is there any special virtue in the dust of the ground, so that he should be more likely to be a higher human being if made out of that than if developed from the most intelligent of the brute creation? Why may we not argue in just the other direction, and say the higher the origin from whence he sprang, the higher nature and destiny we have a right to claim for him? And, assuredly, an origin from other forms of animal is higher than an origin from inanimate earth. If it be maintained that the instantaneous creationist does, indeed, get man from the mass of dust, but that it is by the power of God, and that therefore he gives to man a nobler origin, the answer is ready and is conclusive. The evolutionist also traces the growth of man to the power of God. He confesses that as much intelligence, as much power, as much wisdom are necessary to make an animal life, out of which has been unfolded man, "the crown and glory of the universe," as to make a man. He assumes that behind all phenomena there is that Infinite Power which theists call God. He no more thinks that man can come into being without the action of this Power than he thinks force can come from nothing. Both evolutionist and instantaneous-creationist, then, refer man's ultimate origin to God.

My final answer to this misconception is this—that evolution does not, strictly speaking, attempt to investigate man's nature at all. The ground that it examines is not metaphysical or theological. Taking man as he is, as we all see him and know him, it asks the simple question, How came he to be what he is? Was it by a single, sudden act of creation, or by a process of gradual development? If the facts, when they are collected and arranged, should prove that man has been evolved from lower forms of life, that he is the result of an intricate growth through millions of ages, this conclusion will not so much as touch his present high mental and moral position. Be the pathway by which he has come to this position whatever it may, he now breathes the air, looks upon the light, hears the voice of nature in her countless tones, rests upon her fragrant lap, is conscious of a beating pulse; nay, more, he is a being glorified with the perception of beauty, with the sentiment of grandeur, with the radiance of fancy, and with the graces of culture; he is a being cheered by the warmth of friendship, by the sweetness of affection, by the associations of memory, by all that stirs a kindred and loving humanity; nay, higher still, he is a being crowned and sanctified by the sacred convictions of religion. Was man cradled in a little globule of protoplasm? Be it so. These words of Shakespeare remain as relevant and beautiful as ever: "What a piece of work is man! How noble in reason! how infinite in faculties! in form and moving, how express and admirable! in action, how like an angel! in apprehension, how like a god!" Shall we trace our descent from an ancestry of apes or of infusoria? Be it so. It still remains true that man is at a level of being which is a mountain of transfiguration, and which he has reached by an ascending pathway, bright and grand as the sloping beams of light that bridge the deeps of space from the horizon's edge up to the unbearable glory of the rising sun.

4. Another cognate misconception. A great many excellent people are afraid that, if they admit they have been developed from the lower forms of life, they are in danger of losing their souls and their hope of immortality. But if we are made out of the dust, where did we get our immortal souls? If we have developed out of some lower form of animal life, is there any more mystery about the soul than on the

other theory? I am what I am, on either theory. Mr. Darwin expressly maintains that his system of evolution does not negative the idea of a divinely-communicated undying soul as belonging to man.[13] A subtle thinker, whose name is well known in this city, and whose philosophic genius is of a high order, the Rev. Allanson Picton, acutely observes that none of us can say at what moment the immortal soul is communicated to the child in the womb, and yet we do not doubt that the communication takes place.[14] In like manner, argues Mr. Darwin, referring approvingly to Mr. Picton, the immortal spirit may have been communicated to man by his Creator at some point in his natural evolution, although we are not able to fix that point.[15] As I conceive, the theory of Mr. Darwin does not touch the question of my spiritual nature or my immortality. The truth is, I am what I am, whatever the channel through which the human race had its beginning. And for my destiny, since some power has shown itself capable of making me what I am, is it any greater wonder or mystery to suppose and believe that this same power, whatever it may be, shall also be able to continue the existence it has given? I am lost in the wonder that I live. It is no more wonderful to me that I may continue to live.

5. This brings me to the last misconception of Darwinism to which I shall refer to-night—the common misconception, namely, that it is godless, atheistic, that it involves the exclusion of God and of design from the universe. In reply to this, I have to say, in the first place, that the contrast is not between evolution and creation, but between creation by evolution and creation by sudden and arbitrary successions.

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[13] *Descent of Man*, 2nd edition, 1874, p. 613.

[14] *New Theories and the Old Faith.* By Rev. J. Allanson Picton, M.A., 1870, Appendix, p. 199.

[15] *Descent of Man*, 2nd edition, 1874, p. 613.

When it is clearly apprehended that evolution gives us only the order, and leaves it as before for reason and faith to supply the cause, of the creation, the particular method advocated by the evolutionists is seen to be one that has illustrations of its own to supply concerning the wisdom and beneficence of the Creator. The scheme is so simple in its general principles, and so complex in its operations, as to give us the highest conception of wisdom; the present consummation of the plan in man is so noble, and it lends itself so fully to the hopes that arise out of the present experience of incompleteness, that the general idea of beneficence is at once suggested by it; while the difficulties of evolution arising from the sight of pain and failure, and the constant struggle of nature, are no greater in the theory than in the facts of creation.[16]

In the second place, I would say that the inclusion or the proscription of the ideas of God and of design is irrelevant to Mr. Darwin's object as an expounder of natural laws. A theory which either finds or denies design in nature is properly a branch of metaphysics, and if any reference to it occurs in a work of natural science, it must be regarded as a foreign addition imported from mental science. To say, therefore, as anti-Darwinians frequently say, that the denial of design is an essential feature of Darwinism, is a misapprehension of the proper distinction between mental and physical science, involving the absurdity of incorporating a metaphysical dogma with a fabric of natural science. To this bit of transubstantiation even Mr. Gladstone committed himself when, in his famous address at the Shaw-street College, he declared that in our time, "upon the ground of what is termed evolution, God is relieved of the labour of creation."[17] Darwinism, as a scientific entity, is an exposition of certain laws of nature; whether a true or false exposition must be decided by considerations germane to its own argument. It is not a Theistic or anti-Theistic, much less an Atheistic, system, whatever conclusions may be embraced on these subjects by Mr. Darwin and his followers or adherents. It is quite possible that Mr. Darwin, or any other evolutionist, may consider that he can deduce certain conclusions adverse to theism from his observations of nature. If he chooses to commit the absurdity of affirming that he has proved the non-existence of design, I can only wonder at the portentous metaphysical blunder which he perpetrates, but I am certainly under no obligation to assume that this palpable *non-sequitur* is a legitimate or essential portion of his scheme.

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[16] Professor Huxley writes:—"In more than one place, Professor Haeckel enlarges upon the service which the *Origin of Species* has done, in favouring what he terms the 'causal or mechanical' view of living nature, as opposed to the 'teleological or vitalistic' view. And no doubt it is quite true that the doctrine of Evolution is the most formidable opponent of all the commoner and coarser forms of Teleology. But perhaps the most remarkable service to the Philosophy of Biology rendered by Mr. Darwin is the reconciliation of Teleology and Morphology, and the explanation of the facts of both which his views offer." . . . "It is necessary to remember that there is a wider Teleology, which is not touched by the doctrine of Evolution, but is actually based upon the fundamental proposition of Evolution."—*Critiques and Addresses*, p. 305.

It is plain, I admit, that Mr. Darwin, in his eagerness to bring all the phenomena of life under the operation of the laws of natural selection and evolution, has sometimes used language inconsistent with the ideas of theism and of design. If God created the universe and impressed its laws upon it, I, as a theist, am justified in believing that He intended the result, and I have a right to seek for divine ideas and purposes in nature.[18] But Mr. Darwin is impatient with the feeble moralisings which natural theologians have often indulged in, and, in his reaction against their tendency to pick and choose among natural facts only those which support their own foregone conclusions, he has unnecessarily denied their logic, and used language which seems to imply that nature has nothing to teach us about God at all. On the other hand, it is equally plain that Mr. Darwin is not himself an atheist, since in many passages in his writings he refers to God as the origin and source of all things. In the *Origin of Species* he uses these words: "I see no good reason why the views given in this volume should shock the religious feelings of any one. . . A celebrated author and divine has written to me, that 'he has gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the void caused by the action of His laws.'"[19] And in the final sentence of this book Mr. Darwin observes: "There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning, endless forms, most beautiful and most wonderful, have been, and are being, evolved."[20] In the *Descent of Man*, Mr. Darwin remarks of the question, "whether there exists a Creator and Ruler of the universe," that it "has been answered in the affirmative by the highest intellects that have ever existed."[21] It is difficult for me to believe that a man of such transcendent

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[17] Address at the Liverpool Collegiate Institution, December 21st, 1872.

[18] "The teleological and the mechanical views of nature are not, necessarily, mutually exclusive. On the contrary, the more purely a mechanist the speculator is, the more firmly does he assume a primordial molecular arrangement, of which all the phenomena of the universe are the consequences; and the more completely is he thereby at the mercy of the

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teleologist, who can always defy him to disprove that this primordial molecular arrangement was not intended to evolve the phenomena of the universe."—Professor Huxley, *Critiques and Addresses*, 1873, p. 307.

[19] *Origin of Species*, 5th edition, 1869, p. 569.

[20] *Origin of Species*, 5th edition, 1869, p. 579.

[21] *Descent of Man*, 2nd edition, 1874, p. 94.

frankness and honesty would use these words without comment if he meant to dissent from the conclusion stated. Throughout the *Descent of Man*, moreover, Mr. Darwin treats of religion as one of the loftiest and most beneficent agencies in the improvement and progression of the species, which he cannot consistently do if he considers the fundamental proposition of religion—that God exists—a mistake. In view of these admissions and expressions of Mr. Darwin, it is eminently unfair to charge him with atheism. The accusation is equally groundless in the case of other evolutionists. Speaking of those who hold the hypothesis, Professor Tyndall says: "They have but one desire—to know the truth. They have but one fear—to believe a lie. . . . They have as little fellowship with the atheist who says there is no God, as with the theist who professes to know the mind of God."[22] It is, then, an unmanly thing to attempt to fix the stigma of atheism upon the expounders of the evolution theory. Nearly all of them are reverent theists. "I believe," says Mr. Alfred Russell Wallace, "that the universe is so constituted as to be self-regulating; that as long as it contains Life, the forms under which that life is manifested have an inherent power of adjustment to each other and to surrounding Nature, and that this adjustment necessarily leads to the greatest amount of variety and beauty and enjoyment, because it depends on, general laws, and not on a continual supervision and rearrangement of details. As a matter of feeling and religion, I hold this to be a far higher conception of the Creator and of the Universe than that which may be called the 'continual interference' hypothesis; but it is not a question to be decided by our feelings or convictions, it is a question of facts and of reason."[23] Agreeing with Mr.

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[22] *Discourse* on "Scientific Use of the Imagination," British Association, Liverpool, 1870, reprinted in *Fragments of Science*, 6th edition, vol. 2, p. 135-6.

[23] *Contributions to the Theory of Natural Selection*, 1870, p. 265-6.

Wallace that the hypothesis of evolution must stand or fall as the evidence may determine, I agree also with him that Darwinism not only does not deny God, not only does not remove God farther off from the universe, but, proving Him as acting by constant and permanent law, gives to us a nobler conception of Him as the imminent cause and ever-living and present Being. Were we to have proof that every form of life, vegetable and animal, from diatom and rhizopod to man, had sprung from one solitary cell by a process of natural selection, so far from losing sight of God, we should be guided along the actual path through which His creative energy accomplished its perfect work, and hear the very song of the morning stars when the foundations of the earth were fastened and the corner-stone thereof laid, and all the sons of God shouted for joy. The possibilities of growth contained within that primal cell would testify at least as marvellously to the glory of the Lord as a myriad separate creations of independent species. The doctrine of development is an endeavour to explain the method of creation, and can no more be held to dispense with a Creator than an explanation of the metre of a song can be construed into a denial of the existence of a poet. The persistent uplifting of types of being, from epoch to epoch, would prove the ceaseless activity of a living spirit, working out a definite purpose, and manifesting Himself with an ever-brightening glory.

THE INFLUENCE OF LITERATURE UPON THE GROWTH OF RELIGION AND LAW.

By H. LONGUET HIGGINS.

A MARKED intellectual feature of the present age is its study of Development. We are no longer satisfied with studying things as they are; we wish to know how and when they grew up, and what causes and influences have shaped, arrested, or accelerated that growth. The study of growth is indeed a profoundly interesting one, and it is to the development of two great systems of human thought, and to what is conceived to have been a powerful, though unappreciated, influence upon them, that your attention is invited in the present paper.

When we consider the immense part played in human affairs by Literature, which in its widest sense signifies the whole written thought of Man, and when we remember that the possession of a literature is one of the broad distinctions between civilised and uncivilised races, it would seem at first sight not a little remarkable that this great institution, Literature — itself a product of the human mind, and therefore a proper subject for psychological study —has received but little scientific attention. Yet so it is. But it is still more strange that language itself, the material of literature, has only very recently been considered as worthy of scientific investigation for its own sake, and not merely as a key to ancient and foreign wit and wisdom. Again, admitting that Literature *is* worthy of psychological study, let us remember that Psychology herself has but recently ascended from the mist of Metaphysics into the clear atmosphere of Science. This very circumstance is a psychological fact of great interest. It shows that the progress of science and discovery is itself subject to a mental law, whereby we pass from the perception and study of the more material to that of the less material in Nature.* To take an example from physical science: the mechanics of solids were first investigated, the properties of fluids being not accurately known before the appearance of the great treatise of Pascal; while gases, the least material forms of matter, were hardly known before the latter part of the last century, and their molecular mechanics have been the subject of very recent investigations of physicists.

The influence of Literature or Literary Form properly belongs to the Philosophy of Art, and ultimately to Mental Science. And by way of introduction to that branch of the subject which forms the title of this paper, two other contributory influences should be very briefly alluded to.

(1) *The Influence of Language upon Thought.* This was long since noticed, particularly by Bacon and Locke, and has been generally admitted. The meaning of words not only changes greatly from age to age, but it is probable that even in the same generation no two persons use the same term with precisely the same meaning. Hence it is not surprising that (as has been well said) words, simple words, have been and are at the bottom of half the religious and philosophical controversies of the world, and that most of the perplexities of men are traceable to obscurity of thought, hiding and breeding under obscurity of language. We have heard very lately in this Society how much fog surrounds the scientific use of the words "force" and "energy," and the popular use of the term "Darwinism," while at our very last meeting, in the discussion following a paper on Mental Science, it was evidently not clear what should and should not be included under the term "mind." So, too, in primitive days, words were the great myth-makers, and Max-Müller

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* "The progress in the discovery of laws itself conforms to law."—H. Spencer.

has shown us that modern mythology is not altogether unknown.*

(2) *The Influence of Literature upon the growth of Language.* The eminent authority just named has pointed out that what we usually call languages, that is to say, the literary idioms of Greece and Rome, India, and Modern Europe, are artificial rather than natural forms of speech, and that the real and natural life and growth of language is in its dialects. The literary idiom of a country is merely one particular dialect which has been raised to temporary importance, and preserved to a great extent from change, by being made the chosen ship for the transport of literature down the stream of Time.†

The literary growth of Religion and Law has been very similar, and it would seem that they were originally united. You cannot in early ages separate legal from religious rules. We may take, as an instance of this, the Jewish religion, the most important (and to the Jews most sacred) part of which was known to themselves emphatically as the Torah, or Law, and was founded upon a legal code believed to have been divinely dictated. Many other ancient codes of law were believed by the nations possessing them to have been of superhuman origin. The Egyptians, Cretans, Lacedæmonians, Persians, and Hindus, all believed that their laws had been divinely communicated to their respective great lawgivers.‡ This is probably but part of the general belief among ancient nations, that their remote ancestors, and the institutions handed down from them, were of divine origin.

THE COMPARATIVE METHOD.

The materials for a study of the influence of Literature or literary form upon religious and legal ideas must be collected by means of the modern Comparative and Historical Method, the establishment of which has been rightly termed by Mr. Freeman the noblest intellectual achievement of our time.*

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* *Lectures on the Science of Language*, vol. ii., lecture 12. † *Ib.*, vol. i., lecture 2.

‡ Max Müller, *Science of Religion*, p. 151.

Think for a moment of some of the results which have been brought about by this Method. The old "classical" Philology has been swallowed up in Comparative Philology, out of which have arisen the kindred, and as yet infant, sciences of Comparative Mythology and Comparative Religion. Comparative Jurisprudence and Comparative Politics are further results of the new Method. The provinces of National and Prehistoric Archæology have been added to the old or "classical" Archæology. We have at last learnt that the so-called "classical" languages, literatures, and archæology of Greece and Rome are by no means the only ones worthy of man's study, and thus the new Method has broken down a sacred ring formed by the prejudices, ignorance, or indifference of centuries. It has established the new sciences of Ethnology, Sociology, and the as yet un-named Science of Culture or Civilisation, and has shown us that all of these are included in the new and comprehensive science of Anthropology; and, finally, that Anthropology itself, the natural history of man, is but the highest department of the great Science of Life in general, whose very name, Biology, only dates from the commencement of this century.†

The establishment of the Comparative Sciences of Language and Religion has been mainly due to the study of the far East, which has shown us that there lies the home of our remote forefathers, and that we Englishmen are indeed an Oriental people, speaking an Oriental tongue. Moreover, in the East we actually see the Past in the Present, just as when we look at the stars we see them, not as they are at the moment, but as they were years before. This study of the East has resulted in the successive discovery and decipherment, during the present century, of three of the most ancient literatures of the world: (1) the Sanscrit, and its allied Buddhist literatures; (2) the Egyptian; and (3) the Assyro-Babylonian. It will help us to realise the antiquity of these three literatures if we remember that the Greek literature commences with the Homeric poems in the ninth century B.C., and that the oldest Greek manuscripts are some Egyptian papyri of about 160 B.C. Roman literature is of course later than the Greek; it may be said to commence with the Law of the Twelve Tables, 450 B.C., and the oldest MS. is probably the Vatican Virgil, of the fourth century A.D. There is but one Hebrew MS. older than the tenth century A.D., and (owing to the damp climate) very few Indian MSS. are more than five hundred years old.*

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* *Comparative Politics*, p. 1; and see his Rede Lecture on *The Unity of History*.

† Treviranus, *Biologie*, vol. 1, 1802.

(1) The real knowledge of the Sanscrit or ancient Indian literature may be said to date from the year 1808. The earliest period of the Vedic, or oldest portion of this literature, *ends* about the year 1000 B.C., and the language itself ceased to be spoken at least 300 B.C. In the third decade of this century, four complete and extensive Buddhist literatures were discovered, those of Ceylon, Nepal, Tibet, and Mongolia.† The first, that of Ceylon, written in the ancient and extinct Pali or sacred language, a descendant of the Sanscrit, is interesting to us among other reasons, as containing the earliest known forms of many of those fables which we are accustomed to attribute to Æsop, and which, be it remembered, originally formed and still form part of the *sacred* literature of the Buddhists. The Buddha taught chiefly by fables or "birth-stories," which had a close resemblance to parables or allegories.‡ The Tibetan literature is

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* Weber, *History of Indian Literature*, pp. 182, 318.

† M. Müller, '*Chips*,' vol. i., p. 194.

‡ See Rhys Davids' *Buddhist Birth-Stories* (Trübner, 1880).

remarkable as containing the largest Bible in the world, the Tibetan sacred canon consisting of two collections; (*a*) the Kanjur, in 108 volumes folio, comprising 1083 distinct works; and (*b*) the Tanjur, in 225 folio volumes.

(2) The still more ancient literature of the Egyptians was next deciphered, the complete key having been furnished by Champollion about the year 1822. The most venerable relic of this venerable literature is what is probably the most ancient book in the world, the *Maxims of Ptahotep*. This work dates from the age of the Pyramids, not later than 3000 B.C., and therefore 2000 years before the time of Solomon. Yet this, the oldest literary relic of humanity, *itself appeals to the authority of antiquity*. Ptahotep, its princely author, tells us that he writes in his old age for the benefit of the young, whom he desires to instruct in the wisdom of the past. The style is proverbial, much resembling that of the Bible Proverbs, written at least twenty centuries afterwards.* The later or demotic period of the ancient Egyptian literature has been but recently investigated, and the curious fact is revealed to us that the wife held the chief place in the family, and that all the wealth of the middle and upper classes of the country was absolutely vested in the hands of the married women. When a man married, he literally and not figuratively endowed his wife with all his worldly goods, and she, during the marriage, had the fullest power of disposition over both her own and her husband's property. In those enlightened days men's, and not women's, rights must have been a burning subject.

(3) Our knowledge of the contents of the wonderful clay libraries and literature of the library-cities of ancient Assyria and Babylonia dates from the exploration by Mr. Layard, in 1850, of the great clay library of Assurbanipal at Nineveh. Then was revealed to us an extensive and varied literature

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* Renouf, *Hibbert Lectures*, 1879, p. 76.

extending back to more than two thousand years before Christ, and the most deeply interesting and unexpected discovery was made, that a large proportion of the works consisted of translations from a still more ancient literature, originally written in Accadian, which was not a Semitic, but a Turanian language, closely allied to the Finnish, and which became extinct before the seventeenth century B.C. For the study of this dead language the ancient Babylonians were obliged to compile dictionaries, grammars, and reading-books; just as we do now-a-days for *our* classical languages; and the Babylonian priests were compelled to recite their prayers and hymns in the original Accadian.

The great library-cities or universities of Babylonia strangely remind us of our own modern civilisation. The free public libraries in these ancient haunts of learning on the banks of the Euphrates, four thousand years ago, were well arranged. Each tablet had its number and proper place, and in the catalogue of the astronomical library of Agane there is a direction to the student to write down the number of the tablet or book he is in need of, and the librarian will thereupon give it to him.

The Assyrian political conquest of Babylonia was, like the subsequent political conquest of Greece by Rome, followed by the nobler intellectual conquest of the conquerors by the vanquished nation, and the Assyrians studied and preserved the literary treasures of Babylonia with as much interest and ardour as the Romans did those of the Greeks, and as we do those of the Greeks and Romans.

Babylonia was the home of Semitic culture, and the birthplace of astronomy, mathematics, and the calendar. It possessed a great national work on astronomy, called the "Observations of Bel," in seventy-two books. The days of the week were called after the sun, moon, and five planets, and the 7th, 14th, 21st, and 28th of each month were sabbaths or days of rest. Every day of the year was sacred to some particular saint or deity. Natural history was not unknown at Nineveh. We have an Assyrian list of all the then known animals, scientifically classified after the Linnæan fashion in families, genera, and species.* The Accadians were eminently a literary people, and one of their creation legends commences by describing the primitive Chaos as a time when there was no writing. We have part of a set of Accadian laws, one of the oldest legal codes in the world. From this we learn that an oath to do justice was required every day from the judges, that the life and status of the slave were provided for, and that descent was traced through the mother and not through the father, the mother thus holding the chief place in the family. In the later Babylonian or Semitic times, and in the Babylonian translations of the primitive hymns, this order is reversed, for among the Semitic nations the woman was held to be inferior to the man, a notion which still survives in modern Europe. The Babylonians were great bankers, and we have the deeds and papers of a great banking firm which carried on business at Babylon for more than a century (from about 600–500 B.C.). The bank calendar is preserved, and we find recorded the succession of bank holidays,† due perhaps to the efforts of some Sir John Lubbock of those days.

THE MIGRATIONS OF THE GREAT RACES.

For the Pre-literary period of Religion we must go back in imagination far into prehistoric times, to a period when the three greatest races of mankind, the Turanians, the Aryans, and the Semites, were still dwelling in their original homes in Bactria and the lands to the east of the Sea of Aral. The Turanians were the first to migrate, and they carried with them into Finland, Media, Chaldea, Persia, the south of India, Mongolia, China, and Japan, their common worship of ancestral and nature-spirits, together with a shadowy belief in a Supreme Power, arising out of that mental faculty of perceiving unity in variety without which no intellectual progress is possible. Next came the great migrations of the Semitic and Aryan races, all of which were completed long before the dawn of history. From the evidence of language, the primitive Semitic religion was polytheistic, and the national religions which grew out of it, except the Jewish, appear to have continued to be more or less so. Each of the Semitic nations adopted a particular god as its peculiar national deity, adding to him many subordinate and ministering gods. Among the Jews alone was the monotheistic influence strong enough to finally triumph, though after many relapses. The primitive Aryan religion was a worship of the many manifestations of Deity in the various influences of Nature, also with a dim perception of a Supreme Divine Being, a 'God above all gods.'* The Western branch of the Aryans sent wave after wave of population into Europe, and founded the European systems of mythology, all of which have very striking resemblances to each other and to Eastern beliefs, the differences being in many cases due probably to influences of climate and temperament. The Eastern branch separated into the respective colonizers of Bactria and India, and the quarrels between these two divisions caused the gods (devas) of the Indians to become the demons of the Iranians, and *vice-versâ*. This is the earliest known religious struggle. To the epoch we have been considering belongs the Age of Hymns to the Gods in India and Chaldea, ending in the latter country about 2300 B.C.

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* Lenormant, *Ancient History of the East*, i., 447.

† Sayce, *Babylonian Literature*, p. 68.

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* 'He Who alone is God above all gods.' *Rig-Veda*, x., hymn 121.

CREATION LEGENDS.

To this Pre-literary period also belongs the first growth of that remarkable series of Legends of Creation and of the early abode of man which appear to have been common to the Aryan and Semitic races, and which are shown in the accompanying diagram. We may divide them into four principal groups: legends of Chaos, legends of Eden or the primæval abode of man, legends of the Origin of Evil, and legends of the Flood.

(1) The origin of all things from a dark Chaos is common to the Jewish, Babylonian, Greek, and Hindu traditions. In three of them, viz., the first of the two accounts of Creation in the book of Genesis, in one of the recently discovered Babylonian legends, and the Hindu account, it was a watery chaos,—an ocean without light.

(2) The Garden of Eden, too, or primal abode of man, is a legend common to many nations. The Babylonian account was probably similar to the Jewish, but it has not yet been recovered. In the Aryan accounts, namely, the Hindu and the Persian, the garden was situated on a high mountain, and though this is not stated in Genesis, the fact is expressly mentioned by the prophet Ezekiel in his description of Eden (Ezekiel xxviii. 13, 14). It is curious that the four rivers and the sacred trees in the midst of the garden are found in the Persian and Hindu accounts.*

(3) The Babylonian account of the Origin of Evil introduces us to the earliest trace of a belief in a mighty sea-dragon or sea-serpent, the personification of evil, which was fought with and defeated

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* See an article by Fr. Lenormant in the *Contemporary Review* for September, 1881.

LEGENDS OF GENESIS.

Legends relating to		SEMITIC.		ARYAN.		
		Jewish.	Babylonian	Persian.	Hindu.	Greek.
I. THE CREATION	Genesis	Dark chaos of waters (Tehôm)	Chaos of the deep (Mummu Tiamtu)	Empty space	Darkness of ocean [*Rig Veda*, bk. x., hymn 129]	Dark chaos
	Creator	1st account, Elohim 2nd „ Jehovah Elohim	Bel the Demiurgos	Ormuzd	Spirit of love	Spirit of love [*See* Hesiod's *Theogony*, 850-800 B.C.; Aristophanes, the *Birds*, 414 B.C.]
	Time occupied	Six "days"	A number of periods	Six periods or epochs (gahanbars)		
II. PRIMAL ABODE OF MAN	Holy Mount	Har-kodesh (*Ezekiel*)		(Zend) Hara-Berazaiti (Parsi) Alborj	Mount Meru (? S.W. of Tibet)	
	Garden	Gan-Eden	Gan-duni Region of Eridu	Garo Nmânem	Garden of Brahma and Uttarakuru (outer land)	
	Sacred fountain			Ardvi-çura		
	River	(Nâhâr)		Arvand	Ganga, which forms four lakes, then four rivers	
	Four rivers	Pison and 3 others				
	Sacred trees	Tree of life	Sacred pine-tree in Eridu	White Haoma or Gaokerena (tree of life)	Djambu	
		Tree of good and evil		Viçpa taokhma (tree yielding every seed)	Kalpataru	
III. ORIGIN OF EVIL	First human pair	Adam ("man") and Chavah ("living")	[Struggle of the God of light with sea-dragon or sea-serpent]	Meshia and Meshiana		
	Evil principle	Serpent		A 'dev'		
IV. THE DELUGE	Hero and companions	Noah and seven others	Tamzi or Hasisadra Gr. Xisuthrus	Yima	Manu and the seven sages	Deukalion and Pyrrha
	Means of safety	Ark (Tebah)	Ship	Vara (a square garden or enclosure)	Ship	Ark
	Mountain	Ararat	Nizir (Mount Elwend)		Naubandhana [*See* Satapatha Brahmana, 6th cent. B.C.; Mahabharata, 5th to 2nd cent. B.C.]	Parnassus

by Merodach, the god of light. In the Persian account it is a "dev," or evil spirit, which tempts Meshia and Meshiana, the first man and woman.

The Eden legend is probably a reminiscence of the early homes of the great races, to the east of the Sea of Aral, for it is noteworthy that the Semites placed the 'garden' in the east and the Hindus to the north.

(4) The fourth legend, the most widely spread and perhaps the most interesting of all, is that of the Deluge. The discovery of the Babylonian version in 1872 caused intense public interest and curiosity, especially as the resemblances to the Jewish story are very striking. But we miss in the Babylonian account the beautiful and poetical ending of the rainbow, which is peculiar to the book of Genesis.* At present we are unable to account satisfactorily for the origin of this legend. It has been doubted whether the Persian story of Yima is in reality a Deluge tradition. Yima, the King of the Golden Age, forms, by the direction of Ahuramazda, a square garden or fenced estate, whereby to preserve mankind and their flocks and herds from the floods and frosts of winter. He is commanded to bring into this district the seeds of all forms of life, both animal and vegetable. (*Vendidad*, ch. ii.) If this is indeed a story of the Flood, it presents a remarkable variation from the other accounts; but it corresponds to a certain degree with the Babylonian version, which is found in the eleventh book of the great national astronomical epic, this book corresponding to the

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* See G. Smith, *Chaldean Account of Genesis*, 2nd edit., 1880; *Records of the Past*, vol. vii.

> sign Aquarius and the rainy month of the year. It would almost be strange if the half-civilised and primitive tribes of mankind, who manufactured mythical stories out of almost every power and influence of Nature, had not invented some legend corresponding with the rainy season which is so marked a feature in many parts of the world. This appears to me to be a rational and probable conjecture, and the idea of a punishment of mankind would so naturally connect itself with the destructive influence of rains and floods, that the moral element found in many versions of the story would not present any insuperable difficulty.

The Tower of Babel is not so universal a legend as those we have been considering, and therefore has not been included in the diagram. But the "Tower of Tongues" was one of the most ancient Chaldean stories, and one of the national traditions of the Armenians.*

THE EARLY LITERARY HISTORY OF RELIGION.

(1) The earliest literary period of Religion, Law, and mythology begins when each nation begins to weave its religious, historical, and other traditions, fables, and legends into a connected form, which often takes the shape of a great national epic, this being at first preserved in the memories of the people or their minstrels, and not for some time reduced to writing. It is important here to observe that though it is true that there can be no *literature* in the exact meaning of the word, which does not consist of *written* works, yet for the purpose of our survey we must extend that meaning. For instance, in India a literature does not necessarily consist of written works, for nearly the whole of the enormous sacred literature of Hinduism has been for centuries preserved in

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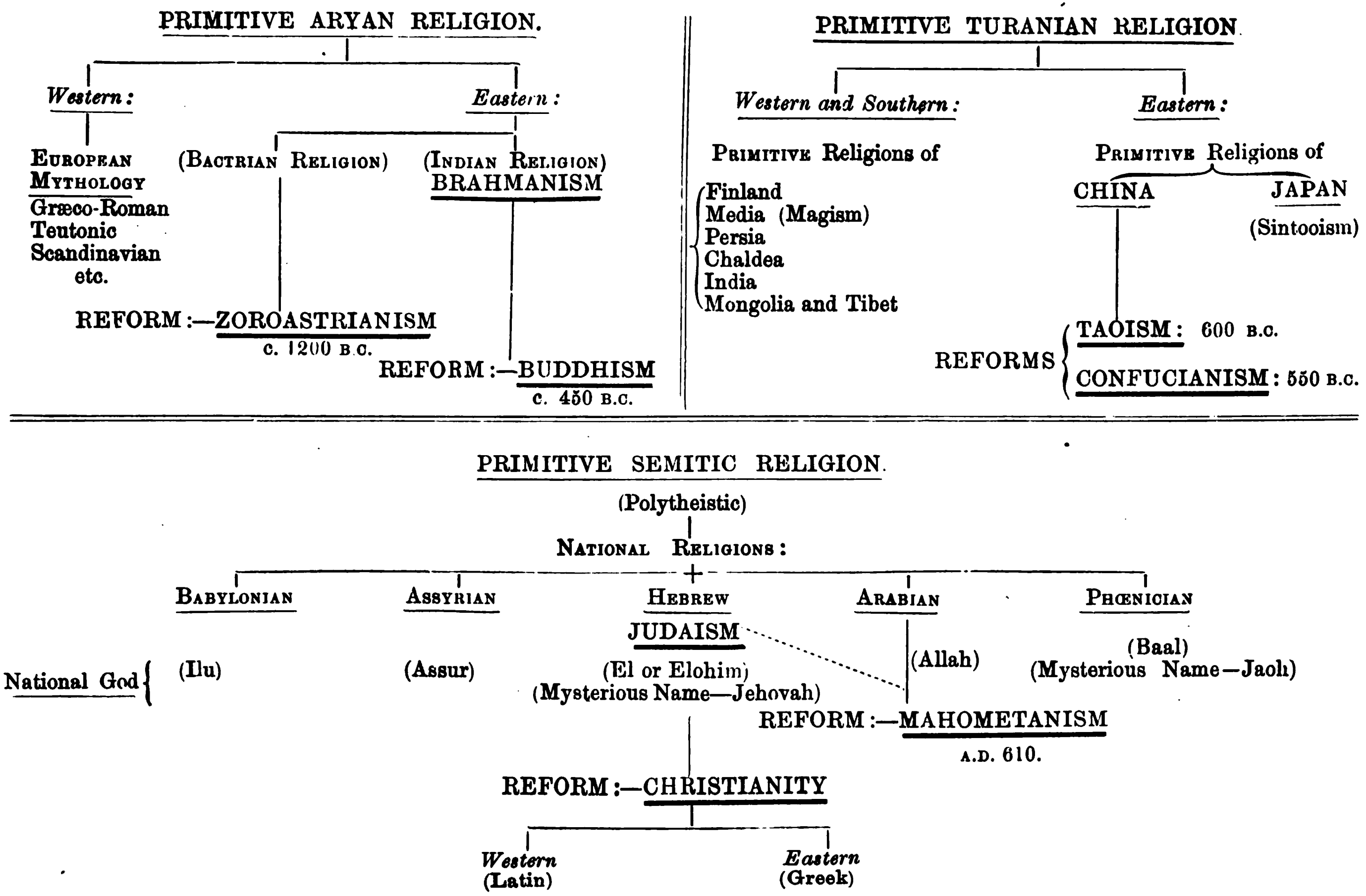
* Lenormant, *Ancient History of the East*, i., 22.


PRIMITIVE ARYAN RELIGION.
Western:
Eastern:
European Mythology
Græco-Roman
Teutonic
Scandinavian
etc.
(Bactrian Religion)
(Indian Religion)
BRAHMANISM
REFORM:—ZOROASTRIANISM
c. 1200 B.C.
REFORM:—BUDDHISM
c. 450 B.C.
PRIMITIVE TURANIAN RELIGION.
Western and Southern:
Eastern:
Primitive Religions of
Finland
Media (Magism)
Persia
Chaldea
India
Mongolia and Tibet
Primitive Religions of
CHINA
JAPAN
(Sintooism)
REFORMS
TAOISM: 600 B.C.
CONFUCIANISM: 550 B.C.
PRIMITIVE SEMITIC RELIGION.
(Polytheistic)
National Religions:
Babylonian
Assyrian
Hebrew
Arabian
Phœnician
JUDAISM
National God
(Ilu)
(Assur)
(El or Elohim)
(Mysterious Name—Jehovah)
(Allah)
(Baal)
(Mysterious Name—Jaoh)
REFORM:—MAHOMETANISM
A.D. 610.
REFORM:—CHRISTIANITY
Western
(Latin)
Eastern
(Greek)

the memories of the Brahmans, who devote many years to the committal of it to memory. Each Brahman is a living library. We have instances of this National Epic period in the Homeric and Hesiodic poems (940–800 B.C.), which, though not reduced into writing until a comparatively late period in the history of the Greeks, crystallised and fixed the national religious belief for many a hundred years. The national epic of Chaldea (circ. B.C. 2000) must also be referred to this period.

(2) The next step in the literary history of Religion is the rise of the great literary religions of the world, of which there are but eight, or if we reckon the Egyptian and Babylonian, ten. The smallness of this number seems less surprising when Max Müller informs us that the greater number of languages spoken at the present day possess no literature.*

The relationship of the great religions to each other is shown in the accompanying diagram. [The literary religions are those strongly underlined.] It will be seen that the primitive Aryan faith has produced one great original literary religion, Brahmanism, of which the reform, Buddhism, has been banished from its Indian home and overspread Asia. So the primitive Semitic faith has produced one great original literary religion, Judaism, of which the reform, Christianity, has been banished from its birthplace and has overspread Europe. The other great Semitic reforming religion, Mahometanism, has spread greatly in Africa, Persia, the Turkish empire, and India, and is even now making greater progress than Christianity in many parts of the world. It is interesting to notice that all the great reforming religions we have mentioned are missionary religions, while their parent faiths were not so.

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* *Lectures on the Science of Language*, i., 52.

The earliest Aryan reforming religion is that of the great Bactrian lawgiver, Zoroaster, and as he is supposed to have lived in the twelfth century B.C., it is much the earliest reforming religion with which we are acquainted. Zoroaster abolished idolatry and the demon-worship into which the religion of his countrymen had degenerated, and proclaimed the one living God, Asura or Ahura, to be known as Ahuramazda, the Creator of the Universe. The moral code is comprised in six words, "good thoughts, good words, good deeds," and these again are summed up in one word, *Asha*, righteousness. That by which Zoroastrianism is usually known, its prominent dualism, is a later teaching than the pure and noble monotheism of the Founder; but it is this dualism which makes the ancient faith most interesting to Christians, for Zoroastrianism had, through its offspring, Manichaeism, a great and deteriorating influence on Christianity, especially giving a great development to the doctrine of a hierarchy of evil spirits or angels, and to the personification of the supposed powers of evil.

We have but few literary records of primitive Turanian faith, but the ancient books of one country, China, were collected by the great reformer Confucius, and almost at the same time another Chinese reformer, Lao-tse, founded a system which has also lasted to the present day, side by side with Confucianism and the imported Buddhism, in that strangest of lands. In Japan the ancient Sintoo faith still continues to be the religion of the Court, which has also a language and a literature peculiar to itself and to men of rank and learning. We can hardly call Confucianism a religion, for it has no reference to a future life or to a belief in a divine being or spirits. Probably the secret of its great success was that it laid before the people an ideal of life, to which all might attain. In this it resembles two other great reforming religions, Buddhism and Christianity, which may be correctly described as the universalisation of the faiths from which they respectively sprang. The formal part and outward history of Buddhism present very striking resemblances to those of Christianity. But Buddhism, like Confucianism, can hardly be said to be a religion at all, as it has no belief in the soul or a future life, and there is no acknowledgment of a divine being or beings.* Confucius, also, particularly avoided all reference to death and supernatural beings, and urged the study of Life. When asked concerning death, he answered, "While you do not know life, how can you know about death?" His teaching was that every man should try to lead a perfect life, the welfare of the State being the ultimate end in view. Though Confucius did not forbid, but rather enjoined, the ancient custom of reverence paid by his countrymen to the spirits of departed ancestors,† this is not really, though apparently, inconsistent with the fact above stated, that Confucianism proper, as a politico-religious system, does not take into account or recognise divine beings, the soul, or a future life.‡

The Chinese are usually cited as the chief instance of a non-progressive race, but I am not sure that this non-progressiveness has been commonly attributed to what is probably its chief cause, namely, that the people are the most striking example of a complete literary bondage that the world has seen. No great Reformer has yet arisen to break the spell which their nine ancient classical books have exercised over the hearts and minds of untold millions. These books have been the sole subjects of competitive public examination in China since the seventh century after Christ. Mohammedanism is perhaps the next most striking example of a literary captivity, for while it remains impossible for true and devout Mahometans to alter in the slightest degree their religion or law as fixedly settled by their great Prophet, it is also impossible that any nation which is under this unfortunate bondage can make any material advance in civilisation.

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* Rhys Davids, *Buddhism*, pp. 96, 98, 99, 150.

† R. K. Douglas, *Confucianism*, p. 121.

‡ Ib., pp. 68, 81, 118.

(3) The next literary period in the history of Aryan and Semitic religion is marked by a great prominence given to public religious sacrifices and ceremonies, and the corresponding rise of a sacrificial literature containing the most minute directions as to the performance of the elaborate ritual. The Jewish sacrificial period has its exact parallel in the Brahmana period of the Sanscrit literature.

(4) Next arises a disgust with the intense formalism of the sacrificial rites, and a formation of schools of philosophic, legal or mystical thought, prominence being given to doctrine rather than to ritual. We have evidence of this period in the proverbial books of the Jews, and the rise in India of mystical treatises known as the Upanishads, and the six Brahman schools of philosophy. To give an idea of the length to which mysticism of thought was carried in India at this period, it may be mentioned that some of the most ancient of the Upanishads are appended to the Aranyakas, or "forest-treatises," so named because they contained certain chapters so awe-inspiring and profound that they were required to be read in solitude in the depths of the forests. This philosophical period had been reached in Egypt at the remote date of Ptahotep, to whose work I have already referred you, viz., 3000 B.C.; and a school of moral philosophy thenceforth prevailed in Egypt side by side with the older religion for close upon 3000 years.

(5) A subsequent stage in the literary history of religion consists of the *gradual collection of many of a nation's public books into a canon*, the older books being always considered as more sacred than the later. We have good

instances of the various degrees of sanctity attached to different portions of the same canon or collection in the cases of the Jews and of the Chinese. The Chinese "Book of Changes," which is ascribed to the 30th century B.C., was unintelligible even at the time of Confucius, 500 B.C., and this work, apparently for the simple reason that they cannot make it out, has always been considered by the Chinese as one of the most sacred of their classical books. The stream of explanations and commentaries on the oldest part of this book dates back to B.C. 1200, so that for 3000 years it has been a mystery to the Chinese themselves. The enigmatical characters in it have quite recently * been found to present very striking resemblances to the most ancient form of the Chaldean cuneiform characters, and when we bear in mind that both are of Turanian origin, and that both Chinese and cuneiform characters, like the Egyptian and Semitic, are degenerated hieroglyphics, we see here almost as strange a link between China and Chaldea as the marvellous resemblances of the ancient Irish or Brehon law to that of the ancient Hindus.†

So also among the Hindus, their sacred literature is divided into two great divisions, (1) the older, the revealed or divine portion (the Veda); and (2) the post-Vedic, or traditionary and human portion.

But all this time the language, in obedience to its natural law, has been changing, in spite of the literary fetters imposed upon it, and the older books have become unintelligible except to the learned priesthood. Hence arise such works as the Targums of the Jews and the Pratisakhyas of India, giving interpretations of the ancient sacred texts and elaborate directions as to pronunciation, etc. The extreme development of the influence of the written letter is seen in the later

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* See the *Athenæum*, January 21, 1882.

† On the Brehon Law, see Maine's *Early History of Institutions*.

Masoretic system of the Jews, a most curious production of the human mind.

(6) Finally, we come to the period of the rise of great Reformers, or Founders of Personal Religions. This epoch marks the growth of Morality in spite of textual and priestly influence, and the reforming religion is almost invariably marked by a higher moral tone than its parent, the older religion.

This is a period of very great interest in the history of Religion, for we have, in the original teaching of each great Reformer, religion in its nearest approach to a code of pure ethics, and therefore in its period of greatest purity and least fettered by literary authority. It is very remarkable that, with the exception of Mahomet, the Founders of all the great Personal or Reforming religions have themselves left little or nothing in writing. They resemble such great teachers as Socrates and Epictetus, both in this respect and in another, namely, that in almost every case we derive our knowledge of their teaching from biographies and collections of sayings; written, collected, and preserved by faithful disciples. For instance, the chief record we have of the Buddha's early life is the celebrated *Lalita Vistara*, or gospel of the Northern Buddhists, and much of the teaching of Confucius is contained in the *Lun-Yu*, or Confucian Analects, a collection of his sayings.

Gradually a second sacred literature, that of the reforming religion, grows up, the older commentaries and controversial works on the primitive documents of the new faith being considered as of almost equal authority with those documents, and councils are held, as in Christianity and Buddhism, to settle the literary form of the creed and the limits of the sacred canon. For instance, the Tripitaka, the sacred canon of the Southern Buddhists, was settled at the Council of Patna, held 250 B.C., in the reign of the King Asoka, the Constantine of India, after which missionaries were sent to preach the faith in various countries.

The subsequent history of the reforming or missionary religions is that of their success in foreign lands, and the gradual formation of national churches. This necessitates the rise of a great literature of translations from the ancient texts, first into the learned or literary language of the period, and afterwards (in spite of priestly opposition) into the vernacular. These translations grow in the course of time to be regarded with almost equal veneration, and certainly more real affection, than the original ancient texts, and new translations, though perhaps more accurate, are looked upon with natural disfavour.

THE LITERARY HISTORY OF LAW.

The history of the growth of the great legal systems of the world is marked by very similar features to those of the great religions. The first literary step is taken when a nation obtains its primitive code; such as the Roman Law of the Twelve Tables (450 B.C.), and the Hindu Laws of Manu (5th century B.C.) Each primitive code is, as we have seen, very generally believed to have been of divine origin, and it always continues to exercise a powerful influence upon the legal system of which it forms the fountain head. Not to weary you with details, it must suffice to say that the subsequent history of Jurisprudence is a history of the three principal instrumentalities whereby, among the progressive races of mankind, the primitive code is brought as nearly as possible into harmony with the advancing needs and morality of society. These instrumentalities are, first, commentaries on the ancient text, and collected opinions of learned lawyers, which gradually become regarded as of equal authority with the ancient text; secondly, the introduction of Equity or natural justice, founded upon a supposed Law of Nature, or law common to all nations; and, thirdly, the last and latest instrumentality, that of direct legislation.* The second, Equity, or natural justice, is by far the most interesting of the three. First, because its introduction into legal systems exactly corresponds with the introduction of a higher morality into ancient religious systems by the great Founders of Personal Religions. Secondly, because it is to a scientific study of Equity, or natural justice, that we look for the great future work of Law, namely, the founding of an international code which shall prevent wars between civilised nations. For war is a very primitive and uncivilised way of settling their difficulties and disputes. It shows us that though each member of the European family has attained individually, through the growth of Law, to a state of national civilisation, we are still (excepting a few treaties, too often disregarded) in a state of collective or international savagery and barbarism. This primitive barbarism, therefore, will end, and international civilisation begin, when the new Comparative Science of Law has given us an international code worthy of being adopted and recognised by all nations.

Form in Art-History and in Life-History.

It is, perhaps, not foreign to, but illustrative of our subject to remark that the growth of Literature itself as a Fine Art shows the same progress from prominence of Form to prominence of substance. In every national literature there comes a time when a climax of beauty of form is reached, usually termed the Golden Age of the literature, from which time Form gradually declines, and we reach the epoch of works in which the matter is considered as far more important than the manner, the spirit than the letter. So in History, the most important branch of prose literature, we have first the artistic type, commencing with Herodotus, and reaching its climax of beauty in such authors as Thucydides and Tacitus, and it is not till very recent times, in fact, till the present century, that we get the true decline of History as a fine art, and the rise of the new laborious and scientifically accurate style.

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* Maine, *Ancient Law*, ch. ii.

So in Man, and probably in every other individual living creature, there is a period of the perfection of ideal bodily form; but, as Mr. Ruskin has well pointed out, in Man this is succeeded by an ideal beauty—conferred by soul-culture—of perhaps a purer and higher range than that of the more perfect material form; wherefore we think more nobly of the reverend presence of the old man than of the fair countenance of the youth.* Is not the life-history of each national literature in some sense analogous to this?

A transition from Formalism to freedom is seen in the growth of every Fine Art. If European Architecture had not passed from the rigid formalism of the so-called "Classic" style to the lovely mediæval Gothic freedom of fancy and line, it could never have received its beautiful name of 'frozen music.'†

The annals of Painting show a similar transition from the formalism or conventionalism of Early Christian Art to the modern freedom both of subject and treatment.

And the history of Music,—more nearly related to Literature than any other fine art, both being Time and not Space Arts,—is but the history of Form; first the emancipation from the ancient diatonic severity of ecclesiastical modes and counterpoint, and the transition to the modern beautiful free or chromatic style; then the perfection of musical forms in the days of Mozart and Beethoven,—the Golden Age of Music—and lastly, the decline of the influence of Form since that time, while the so-called 'music of the future' is specially characterised by a greater or less degree of formlessness.

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* *Modern Painters*, vol. ii., sect. i., ch. 14.

† De Stael and Goethe; quoted by Emerson, *Works*, ii., 158.

CONCLUSION.

In conclusion, three main results may be stated at which we arrive from the study of the literary history of Religion and Law. Literary Form has ever been a principal supporter and agent of ancient Authority and Dogma in matters of faith, belief, and opinion, and has thus exercised a powerful retarding influence on intellectual and moral progress.* It is but two or three centuries since even Science herself emerged from her literary or authoritative stage. Indeed, to write the history of Authority would be to write the history of Thought. The opposite influences, those of the growth of Ethics and of a spirit of intellectual freedom, have periodically produced mighty reforms in the rigid formalism of religious and legal systems, but these reforms have themselves in the course of time crystallised into formalism, and rendered fresh changes necessary. Secondly, the accurate study of both Religion and Law has been sadly impeded by the notion that pure Ethics or Morality has a *necessary* connection with each of them. That this is not the fact is a conception which is only just beginning to dawn upon men. Lastly, as the history of Ancient Law shows us a transition of the unit of society from the Family to the Individual, or, in other words, the gradual rise to importance of the Individual and individual rights,† and as the history of Property exhibits a corresponding progress from joint to individual ownership,‡ so in the intellectual ascent of Man we pass from thinking and believing in crowds to individual freedom of thought and belief, and from a bondage to the letter that killeth to the free service of the Spirit which giveth life.

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* This influence must be carefully distinguished from the apparently opposite influence which the spread of literature in general, as distinguished from particular works and from literary form, has had (especially since the invention of printing) in promoting education and knowledge of all kinds.

† Maine, *Ancient Law*, p. 168.

‡ Ib., pp. 259, 268, 270.

FRESH LIGHT ON "ROMEO AND JULIET."

By EDWARD R. RUSSELL.

I HAVE felt some hesitation in offering this short paper to the Society, because there is presumption in supposing that one can throw, or even reflect, any fresh light on a work which has been so long studied by all lovers of dramatic poetry; and because the presumption is of a kind peculiarly distasteful to many of those who most sincerely admire and enjoy Shakspeare's writings. They naturally and properly prefer the broad and leading conceptions of the plays, which they take to be, and which should be in the main, from the nature of dramatic work, obvious; and they are jealous of subtle suggestions, which they think are apt to be rather ingenious than true, and in any case disturbing to the proper proportions of a play's effect.

Believing that this feeling largely originates in very honest reverence and love, I should be sorry to be even suspected of running counter to it. Hazlitt said, "If we wish to know the force of human genius, we should read Shakspeare. If we wish to see the insignificance of human learning, we may study his commentators." And what Hazlitt thus said of pedants may have been deserved by some of us less technical critics who have valued ourselves more on any little gleam of fresh light that we could direct upon the pages of Shakspeare than upon any show of scholarship. Yet the question must be whether what we offer lights up or obscures the author, and surely it were rash to say that any the merest corner or the slightest trait of Shakspeare does not deserve to be illuminated.

Besides the reason for diffidence which I have thus stated and overcome, there is also an apprehension lest it may seem an impertinence to offer small suggestions as to the intention of a great play, on the occasion, as everyone must guess, of a representation at a particular theatre. I assure the Society that I am quite sensible that this is not a place for histrionic criticism. But I have several times been permitted, and have not felt it inappropriate, to call the attention of thinkers on Shakspeare among us to aspects of the plays either newly, freshly, or more impressively presented by performances of our time; and you have ere now received with toleration, and even with favour, the contention that readers and critics of the plays are almost certain to derive great light from the genius of fine actors if they will deign to bestow frank attention upon the comments and criticisms which are involved in original acting. I have had the honour of knowing most of the chief players of my time, and I freely confess that I have found most of them very bad critics, whether of acting or of the text. Of those whom in my own mind I should except from this slur, some, though very successful in characters of their own creation, were, in spite of their critical acumen, about the worst and most barren actors of familiar great parts ever seen upon the stage. And that one of the greatest actresses may be one of the poorest and most femininely whimsical of critics has, I am sorry to think, been exemplified in some recent contributions to *Blackwood*. But the profitlessness which often characterises the expressed suggestions of actors does not attend the impersonations of those of them who can be called original. Inarticulate and even erroneous in speech and writing, they have an instinct of insight and a power of revelation on the stage to which even good critics may be much indebted. And the position I have taken in reference to Shakspeare studies in this purely literary and philosophical association has been that when, whether in the smallest or the greatest matters, one who has paid some attention to the author finds the meaning newly lit up for him by the actor, it is a fair, though it may not be an exigent occasion, to invite his brother students to consider the new point or points.

The broad and leading conception of "Romeo and Juliet" has been expressed for all time by Augustus Schlegel in a piece of criticism which for combined beauty, sympathy, and accuracy, stands pre-eminent in Shakspearian literature.

"'Romeo and Juliet' (says he) is a picture of love and its pitiable fate, in a world whose atmosphere is too sharp for this the tenderest blossom of human life. Two beings created for each other feel mutual love at the first glance; every consideration disappears before the irresistible impulse to live in one another; under circumstances hostile in the highest degree to their union, they unite themselves by a secret marriage, relying simply on the protection of an invisible power. Untoward incidents following in rapid succession, their heroic constancy is within a few days put to the proof, till, forcibly separated from each other, by a voluntary death they are united in the grave to meet again in another world. All this is to be found in the beautiful story which Shakspeare has not invented, and which, however simply told, will always excite a tender sympathy; but it was reserved for Shakspeare to join in one ideal picture purity of heart with warmth of imagination; sweetness and dignity of manners with passionate intensity of feeling. Under his handling it has become a glorious song of praise on that inexpressible feeling which ennobles the soul and gives to it its highest sublimity, and which elevates even the senses into soul, while at the same time it is a melancholy elegy on its inherent and imparted frailty; it is at once the apotheosis and the obsequies of love. It appears here a heavenly spark, that, as it descends to the earth, is converted into the lightning flash, which almost in the same moment sets on fire and consumes the mortal being on whom it lights. All that is most intoxicating in the odour of a southern spring—all that is languishing in the song of the nightingale, of voluptuous in the first opening of the rose, all alike breathe forth from this poem. But even more rapidly than the earliest blossoms of youth and beauty decay, does it it from the first timidly bold declaration and modest return of love hurry on to the most unlimited passion, to an irrevocable union; and then hastens, amidst alternating storms of rapture and despair, to the fate of the two lovers, who yet appear enviable in their hard lot, for their love survives them, and by their death they have obtained an endless triumph over every separating power. The sweetest and the bitterest love and hatred, festive rejoicings and dark forebodings, tender embraces and sepulchral horrors, the fulness of life and self-annihilation, are here all brought close to each other; and yet these contrasts are so blended into a unity of impression, that the echo which the whole leaves behind in the mind resembles a single but endless sigh."

Nothing is omitted here. Everything is given at the highest. Nothing is rated too highly or inflated with sentiment in the least degree artificial. A more satisfying criticism it would be impossible to read. Many lovers of Shakspeare will say, What more can be desired? And perhaps they will add, any performance which imports other and especially in any degree incongruous thoughts into the subject must be on wrong lines.

In contesting this I shall avoid all those personal discussions into which elsewhere the discussion might run, only remarking that objections to a too mature Romeo, though perfectly and admittedly valid, are very superfluous in reference to a part which, it has always been allowed, cannot be adequately played by a young actor. A recent critic says in a tone of complaint that Romeo has lately been conceived in quite a new light—meaning that the rendering is too lugubrious. But he curiously enough goes on to quote as the basis of the new conception the two lines in which Romeo is described as

"With tears augmenting the fresh morning dew,
Adding to clouds more clouds with his deep sighs,"

and it would puzzle his ingenuity to show that Romeo ever had many moments in which he could naturally throw his nighted colour off. Romeo's courting is clandestine and most anxious. His marriage is secret. His nuptial visit to his bride's chamber does not take place till he has killed Tybalt and been banished.

In this particular, and others which greatly enrich the drama, Shakspeare has departed from the original story, so as to accentuate the anxious view of Romeo's situation; and except at the moment when he finds the Friar astonishingly complaisant in expediting the wedding, there is really scarcely an opportunity for that boyish exuberance of poetic gallantry which some seem to think the spirit of the part. Note a very exquisite touch in this connection. The liveliest lines in the play, and almost in any play, are in the speech where Romeo says—

"My bosom's lord sits lightly in his throne;
And all this day an unaccustomed spirit
Lifts me above the ground with cheerful thoughts."

But when are these words uttered? When Balthazar is just arriving with the news of Juliet's supposed death. The poet, you see, will not allow his hero to have even a presentiment of happiness—will not let him even taste the rich joy of love's shadows—without cruelly insisting on the altogether sad purpose and drift of the action. I invite you to think whether if the last Romeo is sadder than others, it is not because he has more truly felt the circumstances and necessary mood of the character.

Another glint of new light is afforded by the thrilling tremulousness of the Lyceum Romeo beneath the balcony. And this is led up to indirectly by the restoration of Romeo's previous love for Rosaline to the acted play. Romeo is a bold lover indeed in that he will do all and dare all to obtain the delight of loving and being loved; but he is not one to be bold or strident in the presence of the beloved one. He is of that mould of man to whom—or should we say at that time of life when?—the worship of some woman is an essential of life; and his love is fuller of worship than of any other quality. He has worshipped distantly the cold or unmoved Rosaline. With incomparable daring, but with truth, Shakspeare—discarding the original story which made Romeo look about for a successor to Rosaline in his affections—takes him to Capulet's feast because Rosaline is there. A fine point in the new Romeo is where this is indicated, as the young man, merely to help the servitor who has accosted him, reads over in the market-place the names of the invited guests. And a yet finer is where Romeo, instinct with the spirit which Shakspeare audaciously but consistently intended, turns listlessly from his wistful melancholy contemplation of Rosaline at the ball, and then and there is as it were struck statuelike by the beauty and charm of the unknown girl who is to be his fate. It is a change as sudden as that of Faust from youth to age. As he stands there immobile the love of Rosaline falls unconsciously from him, and he is changed in the twinkling of an eye, or rather without the twinkling of an eye, into the glory and glamour of his new adoration, which is to make him the ideal lover of all future ages. Observe that this is unquestionably the poet's meaning, and that seemingly the incident must have been so enacted in Shakspeare's time. But it is not on record, to my knowledge, in criticism of any representation since, and even in private reading the point has probably been missed, or passed over as a weakness. If Shakspeare did not mean Romeo's new love to be thus sudden, and had not a reason for it, why did he depart in this from the tale as it was told to him?

Whether human life is worth exploring in detail or not may be matter for debate, but nothing explores it like Shakspearian criticism. We have noted the restored Rosaline passages as leading up to the justification of the tremors of the lover in the balcony scene. The keynote of Romeo, we have hinted, is worship, yearning worship. He adores his love, and only slowly realises that he can be adored by her. Now, if love deserves discussing, as it has always been thought to deserve representing in dramatic and poetic fiction, we must surely admit that a worshipping, tremulous lover is more intensely and truly a lover than the mere fascinator who is some play-goers' ideal. This airy, petting, protecting, gallant suitor is much more likely to be loved than to languish for love—to be a loveless Lovelace (I often wonder whether old Richardson meant a pun), or at best a gracious Bassanio, than a stricken Romeo or a lamenting Hamlet. The best player of lovers in my experience was the late Henry Montague, and he, with all his fervour, was prevailingly pensive and tremulous. It is surely good judgment in the latest Romeo, though he may lack the outer semblances which made his former colleague so romantically interesting, to carry to still greater perfection of intensity that soft and sensitive love-making, which not only is truer to Romeo's self-renouncing, self-surrendering character, but realises the fearsomeness and adventure of the balcony situation more fully than any other tone. If I am asked how so wistful and trembling a Romeo—whose speeches in the garden are, as George Meredith has said of another, "the breath of love, delicate, tender, alive with enamoured bashfulness"—how such a youth could so boldly essay Juliet at the ball, the explanation is easy. It lies in the sudden excitement of a new passion and in the innocent license of his masquerading freak as a pilgrim. But all through, Juliet, like many another good girl, does more than half the wooing, and the new Romeo's entirely subordinate, worshipping, and submissive demeanour towards her sheds another ray of fresh light on a part of the play which needed special help, and on which I shall now offer a corresponding suggestion.

Beautiful as is the scene in which Juliet plays upon the doubt whether it is the nightingale or the lark that sings at the moment of the forlorn bride and bridegroom's parting, there is a troubling strain of artifice in the composition. No one ever felt it to be perfectly natural, though many have been excusably indifferent as to whether it was natural or not. Somewhat may be allowed for the suggestion which Coleridge makes as to the whole play, that Shakspeare meant it to approach a poem; but one would prefer that it should not approach a poem so nearly as to be dramatically unreal. Now, as it was suggested by the acting of Modjeska how absolutely prone Juliet is to indulge and to follow, even in most serious crises, the fanciful conceits of her own mind; so now it is suggested by the quaint, acquiescent, imitative elocution of Irving in this nightingale episode, that Romeo, in conformity with his character and in consistency with all the plaintive knightliness of his love, falls in with Juliet's conceits. And this gives a new feeling altogether to the hitherto artificial seeming beauties of the lines.

The recollection of that beautiful upper chamber, seen in the new revival under several exquisitely different lights, reminds me how even mere artistic mounting may help criticism at a point where it has faltered. In Coleridge's delightful notes on this play he puts a sort of query against the fifth scene of the fourth act, where the Nurse discovers Juliet, as she supposes, dead on coming to awake her on the morning of her expected wedding with the County Paris. He says:—

> "As the audience know that Juliet is not dead, this scene is, perhaps, excusable. But it is a strong warning to minor dramatists not to introduce at one time many separate characters agitated by one and the same circumstance. It is difficult to understand what effect, whether that of pity or of laughter, Shakspeare meant to produce—the occasion and the characteristic speeches are so little in harmony! For example, what the Nurse says is excellently suited to the Nurse's character, but grotesquely unsuited to the occasion."

Coleridge was a great man and a noble critic, but I am sure no one will ever attach the least validity to these observations who has found Shakspeare justified against Coleridge by the reality and the beautiful interest of this scene as played so wonderfully by Mrs. Stirling, and as heightened by the luminous Verona morning which pervades the ancient room with more than its own serene, cool light—with the very truest domestic essence of a story which in "approaching a poem," was firmly intended by its author to be kept within the atmosphere of home reality.

The honoured name of Coleridge brings me to the point of the greatest originality in the recent new rendering of the play, and I trust the light thus thrown upon it, though it may be deemed trivial, may not be hastily rejected. Schlegel, whose noble realisation of the broad and leading intention of the play we have once again heard with enjoyment and sympathy, says in another place :—

> "Shakspeare's knowledge of mankind has become proverbial; in this his superiority is so great that he has justly been called the master of the human heart. A readiness to remark the mind's fainter and involuntary utterances, and the power to express with certainty the meaning of these signs, as determined by experience and reflection, constitutes 'the observer of men;' but tacitly to draw from these still further conclusions, and to arrange the separate observations, according to grounds of probability, into a just and valid combination, this, it may be said, is to know men. The distinguishing property of the dramatic poet who is great in characterisation is something altogether different here, and which (take it which way we will) either includes in it this readiness and this acuteness, or dispenses with both. It is the capability of transporting himself so completely into every situation, even the most unusual, that he is enabled, as plenipotentiary of the whole human race, without particular instructions for each separate case, to act and speak in the name of every individual."

Here we perceive the readiness of the true critic to discern and admire in dramatic work the minor and less relevant, but necessary, traits of human nature; for the human nature even of the most cut and dry personage of a drama, moving according to fixed purpose, must have many genuine and distinctive traits that do not promote, though they may brighten and illustrate, the action of the play.

Now I advance upon the histrionic suggestions which have prompted this paper, fortified by subsequent thought, that there is beneath the tragic plot of Shakspeare, consisting of slain friends, poignant separations, spectral frenzies, living entombments, apothecary poisonings, and ultimate duello and deaths in the mortuary precincts of the Capulets, a tragic under-plot of a milder and more psychological nature. It is not only the beauty, nor only the beauty *plus* the tragedy, nor only the beauty and tragedy *plus* the domestic and clan embroilment of love, that Shakspeare exhibits to us. There is also something else, something appertaining more to the feebler and less strenuous, but still real and important, aspects of character, and yet germane to the principal love motive.

A German writer has thus conveniently summarised what is generally seen in the play—"the tragic elements of repugnant family feelings, the youthful intoxication of the love passion, the haste to over-reach hostility, and the funereal issue of such hot desire." This is a sufficiently formidable list, but there is an element omitted which Shakspeare meant to show in the general tenor and in particular scenes of the play, and that is *the lapse into futility of character* which is apt to occur when the whole being is rapturously taken possession of by a great passion.

Romeo was from love what Hamlet was from irresistible weird circumstances and native irresolution. He has the makings of a fine character, and, with such a wife as Juliet must have been to a true husband, would have been as much strengthened by love, if he had not been borne down in the first onset of untoward events, as Benedick was, or as the lover of Julie was in the "Nouvelle Heloise," or as Mill and George Lewes and many other men have been in real life. But so far as the story was permitted to go, love reduced Romeo to be the mere toy and waif of temporary surgings and billows, with no more power than a rudderless bark, or a bark whose head was held by a wild, infatuated helmsman hard on to the rocks.

This impression must have been freshly made by the representation which is now proceeding, and several illustrations might be given of the manner in which it is deepened by the acting. I will content myself with one. It is the scene in which Tybalt tries to fasten a quarrel on Romeo.

Tyb. Romeo, the hate I bear thee can afford
No better term than this--Thou art a villain.
Rom. Tybalt, the reason that I have to love thee
Doth much excuse the appertaining rage
To such a greeting *Villain* am I none;
Therefore, farewell; I see thou know'st me not. [*Going.*
Tyb. Boy, this shall not excuse the injuries
That thou hast done me; therefore, turn and draw.
Rom. I do protest I never injur'd thee;
But love thee better than thou can'st devise
Till thou shalt know the reason of my love:
And so, good Capulet—which name I tender
As dearly as my own—be satisfied.
Mer. O calm, dishonourable, vile submission!
A la stoccata carries it away. [*Draws.*

This scene is usually played without giving the least hint of how Romeo's fibre has been weakened, how his standard of conduct has been lowered beneath that of his friends, that of his world, and that of his own settled judgment, by the monopoly which love has obtained of his mind, and by the peculiar relations which he is necessarily in with those of Juliet's kin and faction. The sort of impression that has usually been produced is that of a very superior young man, too amiable and dignified and too much possessed by thoughts of better things to be capable of engaging in broils; and I need not point out that this view must be much strengthened by the gallant and imposing bearing which, in playing Romeo, actors of more presence than insight are likely to sustain. As Shakspeare, however, so the most recent representative of Shakspeare's hero, fully intends us to behold the seamy side even of this beautiful love-story, and to know that there is a seamy side to it in character as well as in misfortune. Irving gives the speeches to Tybalt with a sort of abject anxiety to avoid a rupture, which brings vividly and painfully to the spectators' minds the difficulty in which he is placed as a Montague by his love for Juliet, and which, by its conspicuous falling short from customary sword-drawing manliness and gallantry, fully justifies the indignation of Mercutio. Nay, it afterwards brings Romeo's own condemnation on himself, though he knows all the circumstances and must make the utmost allowance for them. For when, owing to his fussy and pottering interference Mercutio has been slain, he exclaims:—

> "This gentleman, the Prince's near ally,
> My very friend, hath got his mortal hurt
> In my behalf; my reputation 's stain'd
> With Tybalt's slander—Tybalt, that an hour
> Hath been my kinsman—O sweet Juliet,
> Thy beauty hath made me effeminate,
> And in my temper softened valour's steel."

The bringing out, for the first time, as I believe, of the full depth of the meaning of this self-reproach by previous profound indications of almost mean submissiveness to Tybalt is one of those brilliant achievements of psychological truth which Irving accomplishes by dint of an entirely unconventional and unfettered honesty, insight, and fidelity to essential facts of character developed by incident; in which I take him to be almost, if not quite, unprecedented.

I have suggested that Shakspeare means us to see the seamy side of his love story. I will not now say what has been thought the less commendable side of Juliet's character. It is a side rare, I think, in the young women of our country, whose faults probably lie in another direction, and, as Schlegel has hinted, Shakspeare has masked it with the rarest skill and delicacy. As to Romeo, it is clear that as by his original love melancholy he laid himself open to the ridicule of his friends, so good-natured ridicule passed into decided contempt when they found that under the influence of an absorbing love he had almost parted with self-respect, and become liable to default in the most elementary obligations of a gentleman living in such a place and in such times. And he himself endorses the impeachment.

It would be easy to trace this thread of futility, which in great and small events alike runs through the action of the play as infirmity of purpose runs through "Hamlet." Given the circumstances, and most of the futility, as most of the infirmity, is inevitable; but in truth to nature Shakspeare occasionally lends to an incident a bias arising from character even stronger than is in the majority of the incidents received by compulsion of events. And fresh light is thrown on this and on the seamy side of all love that does not listen to reason by the subtle suggestion of helplessness in many scenes, and of something approaching mean tameness and contrivance in one scene, which the new Romeo has made in the performance of the character.

In conclusion I will only say that the person of the drama who most profits by the meaning of the tragedy thus being brought out, both in the restoration of the Rosaline passages and in the illustration of the reduction of life to valuelessness, except for poetry, by a too overmastering, though innocent and beautiful affection, is Friar Lawrence. Apt to figure in the acting versions as a mere old twaddling and indulgent monk, intent on the emblematical contents of his simple-basket until drawn into a tangle of conduct by sheer good nature, he takes in the revival his proper place as the sententious critic, not only of the violent delights which have violent ends, but of the young men's love that lies not only truly in their hearts but in their eyes, and indeed of the whole course of the wild, pathetic story of which he is the pivot.

Coleridge and others have sought to assume some remarkable difference between Rosaline and Juliet, and we may well be sure that there was not another Juliet in Verona; but Romeo could not know at first that there was any difference between the two girls' characters and minds except in Juliet's coming-on disposition. He absolutely yielded to the almost universal instinct of imaginative youth, and was repaid with a wealth of love and beauty, in which was contained truer and more abundant rapture than are found in a thousand ordinary love-matches. But the friar knew all the same that Romeo had rushed upon his future by impulse, and that a future so challenged might be full of fate. "The mind has made" love "as it peopled heaven, even with its own desiring phantasy" (*Childe Harold*, iv. 121); and where it has the absolute, questionless mastery it is for old monks and cold critics to look on and note the beauty of it, and the destiny of it, interwoven perhaps with accompanying failure and futility, as too often seen in life, and as reflected not less honestly than sublimely in Shakspeare's faithful mirror.

MENTAL SCIENCE IN ITS QUANTITATIVE RELATIONS.

By RICHARD STEEL.

THERE are few subjects so attractive and at the same time so repelling as that which it is my duty to bring under your attention this evening. Whilst all men speculate at times upon the nature of mind, nearly all have also a rooted dislike to the metaphysical trains of thought into which such enquiries often lead them. And thus, although mental science is a topic upon which most of us may be said to think frequently in a fragmentary and discursive way, it is one to which it is comparatively rare to give continuous and effective study.

The fact just referred to becomes, however, somewhat surprising when we consider the further circumstance that the literature of the subject is very copious in its character, and that it comprehends, directly and indirectly, more volumes than have been put together upon any other of the many departments of human thought. Philosophers have filled their learned pages with attempts, by means of an elaborate analysis, to investigate the nature of the immaterial or (as some would have it) less material part of man's being, and to discriminate its different modes under the names of intellect, feelings, passions, and so forth. Theologians of every creed have made it their incidental duty to propound theories of the higher nature of humanity which are co-ordinated to the doctrines and faiths which fervid conviction has led them to inculcate. And that nothing should be wanting in its methods of treatment, writers of fiction from the earliest days of literature have derived the chief interest of their works from the synthetic psychology upon which they are based; for the success of the epic poem, the drama, or of the modern novel has undoubtedly, in the long run, been found to rest upon the accuracy with which it has delineated human character and the complex combinations which result from the play of human motive and human passion.

In spite, however, of all that has been thus written, the indisputable fact remains that, so far as accurate and definite results are concerned, Mental Science is the most backward of all branches of knowledge. Such formularies as it possesses are conveyed in a cloud of words of a highly abstract nature, from which anything of that exactness which characterises the more advanced sciences is conspicuous by its absence. Our mental philosophers may fitly be compared to Milton's contemplative fiends, who

> "——— sat on a hill retired,
> In thoughts more elevate, and reasoned high
> Of Providence, foreknowledge, will, and fate;
> Fixed fate, free will, foreknowledge absolute,
> And found no end, in wandering mazes lost."

Much of the backwardness thus referred to is no doubt due to the inherent difficulty of the subject, but it is also, I believe, in a large measure owing to the fact that students of mind have hitherto most frequently confined themselves to its qualitative rather than to its quantitative aspects. In their anxiety to seize that ghostly knowledge which seems so near us, and which yet so successfully eludes our grasp, they have neglected the surer but more humble methods upon which all the more advanced sciences have found their solid progress to depend. The adoption of sound quantitative processes is essential to the development of any branch of knowledge beyond its first rudimentary stages, in evidence of which fact I will cite just one illustration furnished by the history of chemistry. It is well known that for centuries the alchemists, with their alembics and crucibles, had sought to penetrate the mysteries of nature, but although they and their immediate successors made many discoveries, the sum total of all that was accomplished prior to the time of Lavoisier was but trifling in comparison with the immense accessions which this department has since received. And the reason of this consisted mainly in one simple circumstance. Prior to the time of that eminent chemist the balance had been little used. Even his distinguished contemporary, Priestley, rarely employed it, and confined himself almost entirely to investigating the qualities of the gases which he manipulated. But Lavoisier, by means of accurate weighing, disproved the theory of phlogiston, discovered and formulated the modern theory of oxidisation, and established by his example the future supremacy of exact quantitative method as the true foundation of chemistry. The all-important atomic theory of Dalton, the true starting-point of all subsequent enquiry, followed as a necessary consequence of investigation conducted upon those lines, and thus we have illustrated sufficiently for my present purpose the necessity of quantitative treatment for the successful elaboration of this one science. But the method which has thus proved indispensable to chemistry is in forms varied according to the nature of the subject matter equally necessary in all investigations, and in none more than in that branch of enquiry with some of the relations of which I am endeavouring to deal.

Admitting, then, as we are bound to do, the truth of the proposition just laid down, it is clear that in any attempt to act upon it we are confronted immediately with practical difficulties of a very serious character. Physical substances may be isolated, weighed, measured, and subjected to all the other quantitative processes known to mankind, but the human mind cannot be thus dealt with. And hence it has followed that very little has been hitherto done in the investigation of its quantitative relations, and it will therefore be possible in a reasonable time to give a sufficient sketch of that which has been thus accomplished.

The earliest form which such enquiries naturally assumed consisted in speculative determinations of the particular part of the physical organism with which the mind was directly and immediately associated. Such a determination was obviously essential to any physiological treatment of the subject whatever, and it is curious now, at a time when there is not much disagreement upon this point, to note the important differences of opinion which formerly existed with regard to it. Galen, the father of medicine, taught that the soul lurked in the ventricles of the brain, that is to say, in its cavities. Albertus Magnus, following the psychology of Aristotle, who divided mind into the three departments of judgment, imagination, and memory, assigned the first of these three to the front part of the head, the second to the middle region, and the third to the back part. A physician of later date aroused against himself the deep reprobation of the orthodox medical schools by departing from the opinion of Galen so far as to assert, in contravention to it, that the soul dwelt in the substance of the brain, and not in its ventricles. But although it is thus clear that from very early times many professional students of physiology located the mind or soul within the head, or, more strictly speaking, within the *encephalon*, this was by no means the only theory that obtained general acceptance. Homer appears to have considered that the soul was mixed with the blood; with him the soul floated out in a tide of gore or found an ample passage through the wound of a javelin. An analogous idea was probably implied in the precept conveyed to Noah shortly after leaving the ark, that "the blood is the life," and that, as such, it should not be eaten. An ancient writer again tells us that men laugh with the spleen, rage with the gall, love with the liver, and understand with the heart. The etymology of the word *spirit*, and its equivalents in several languages, remains as a monument to another widely-spread notion that the vital air within us is the vehicle or habitat of the soul. But the localisation which obtained, probably, the widest currency is one which is now quite obsolete, excepting, indeed, that it survives in the way of metaphor. When we speak of a man being *heart whole*, having lost his *heart*, or having no *heart*, we are using a phraseology derived from an opinion once very generally held, that the heart was the seat of the affections, and some part at least of the intellectual power. This was a view largely assumed, for example, in the Hebrew and Christian Scriptures, as very many passages of this sacred literature readily show. And the continual persistence of this theory in our forms of speech is no doubt due to the high sanction which it thus obtained.

All these theories, however, have now been entirely superseded by the modern view which associates mind with brain so completely, that some of our greatest names appear to look upon the former as simply a function of the latter. Thus, for example, we have Mr. Charles Darwin commenting upon the fact that the brain of man and the brain of the ourang do not perfectly agree at any period of their development, and saying, "Nor could this be expected, for otherwise their mental powers would have been the same"*—clearly showing that this eminent naturalist holds the opinion just stated. And a little reflection will readily show that the Darwinian theory of evolution necessarily implies the evolution of mind from physical structure, unless, indeed, we are prepared to adopt the opinion held by some theologians who accept that theory, and who, whilst agreeing that there is no fresh creation of body now going on, and that there has been no such creation for millions of years, hold also the somewhat inconsistent view that minds or souls are still being created, and that at a rapidly increasing rate which has already reached something over thirty millions per annum for the use of the human race alone.

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* *The Descent of Man*, vol. 1, p. 11.

For the universality with which the brain is at present regarded as the special abode or organ of the mind there can be little doubt, however, that we are originally indebted to the phrenological school. And though it would not accord with the plan of my paper to enter upon any extended discussion of this well-known theory of mental localisation, yet, as it is by far the most considerable effort of the kind that has ever been made, I will briefly review its history and claims so far as they have to do with our special subject. And that their relation to it is very considerable becomes evident from the fact that Phrenology is essentially a quantitative method, and therefore, if true, an indispensable accessory to all attempts that may be made to push still further the boundaries of mental science in any such direction.

The system was first founded by Gall, a physician of Vienna, during the closing years of last century. He had observed in early life that certain of his schoolfellows who had prominent eyes had a marked aptitude for the acquirement and use of language. This suggested to him the idea that mental qualities generally might be found to vary according to the formation of the head. He commenced a laborious induction, in the conduct of which he was largely [illegible] by the celebrated Spurzheim, and found so much reason to believe that his hypothesis was a correct one, that he felt warranted in mapping out upon the skull the regions where prominence or otherwise he held to indicate the relative quantity of certain of the mental functions. Although some changes in matters of detail have since been made by the followers of this eminent man, the theory, as such, has remained without change, and we may therefore proceed at once to estimate its true quantitative value.

As a first step, then, it is requisite to point out that Phrenology comprehends within itself two clearly separable hypotheses, although each is adapted to, and grew up with, the other. The question whether the human mind can be correctly and exhaustively analysed into the various faculties of benevolence, combativeness, firmness, &c., as enumerated by the phrenologists, must be answered in the affirmative before the further step of placing these faculties each in its own region can be usefully approached for any quantitative object. As Phrenology professes at the outset to resolve all mental and moral developments into certain primary faculties, much in the same way that the science of chemistry refers us to a certain number of primary substances, from the combination of which all known forms of matter result, it is clear that the first point Phrenology has to establish (from our special point of view) is, that this analysis is a correct one. And this, though the system is extremely ingenious, and though it has engrafted itself thoroughly upon popular language and modes of thought, is a point upon which it appears to me that Phrenology must always fail. Its psychological analysis can never be anything more than an approximation, for it is not conceivable that any phrases which ingenuity could coin, or any definitions which could be assigned to such phrases, could ever be regarded as rigorously exact equivalents for elements so Protean in their character as those which go to build up the mental fabric. And in corroboration of this, it is well known that many of the professed students of Phrenology regard the psychological classification they use as largely provisional, and concede candidly the impossibility of anything like exactness in such a matter.

Assuming, however, that the mind is correctly anatomised by the phrenological classification, the subsidiary question arises, whether each of these faculties is correctly placed in the phrenological scheme or chart. To discuss this matter fully upon the data ordinarily advanced with regard to it would lead me beyond the limits to which I propose to confine myself. And, as it happens, it is as unnecessary as it would be inconvenient to range over so wide a field, for the result of recent scientific enquiries of a very definite character settles the point very conclusively. Some at least of the principal facultative localisations of the phrenological chart have been completely disproved, as the next section of my paper will show. And thus, whilst Phrenology has been a very great advance upon anything that had been previously done in the study of mind, whilst it justly deserves the honour of being regarded as the first real attempt that had been made in a quantitative direction, and whilst it remains possible that in some fresh form it may still have a future before it, yet for the present I am compelled to arrive at the conclusion that it can convey no reliable quantitative teaching, and can therefore carry us no further in the path we have now to pursue.

Although we thus dismiss the claims of Phrenology, there can be no doubt that a great stimulus had been afforded by it to the study of cerebral anatomy. Of late years some remarkable discoveries have been made by the further process of vivisection, and it is to these that I have next briefly to direct your attention.

It occurred to enquirers into this department of physiology to make use of the electrical current for the purpose of discovering whether stimulation by this agency of different regions of the brain would produce any definite results upon the living being. It had long been known in a general way that violent effects might be produced upon the nervous and muscular system by the electrical current, and it was indeed to the observation of such effects upon the limbs of a frog, which his good lady, steel fork in hand, was preparing for the national delicacy of frog soup, that the discovery of Galvani was directly due. But the attempt was now made to obtain specific results from specific stimulation. Portions of the skull in living subjects were removed, the current applied to the cortex or gray matter which forms the exterior surface of the true brain, and the effects duly noted. The result was to show that there was an immediate relation between certain portions of the brain and certain muscular movements. Accordingly as certain convolutions were electrified, the eyes, tongue, neck, and so forth of the animal could be caused to move in a definite manner. And what was found to be true of one animal was found to be true of others. Electrical excitation of corresponding regions produced corresponding results. These experiments were of course made upon subjects of the lower creation, the vivisection of human beings not being as yet permitted, excepting in certain so-called barbarous countries, to which it would not be convenient for the student to repair lest he himself might in turn be subjected to a similar process by the natives, for culinary or other reasons. But M. Luys, in a recent interesting work upon the brain and its functions,* is able, to some extent, to supply the want of experimentation upon the human subject, for he tells us that an American physician, pushing the boldness of experiment to its ultimate limits, obtained similar results in a patient whose brain was denuded by a degeneration of the cranial case or skull.

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* *The Brain and its Functions*, p. 52.

The general result of these investigations may be thus summarised. The cerebrum is usually considered anatomically as consisting of four regions—the frontal lobe, the parietal or middle lobe, the occipital, corresponding with the back part of the head, and the sphenoidal, which occupies the lower middle region of the true brain. The experiments just alluded to have shown that whilst the stimulation of the occipital and a great portion of the frontal lobes produces no traceable effect upon the muscular system, a similar process applied to the middle brain produces definite muscular results. Not only was this the case, but when the brain substance was cut away, so as to apply the stimulus at a more interior part of the same region, similar effects followed. So far, therefore, as the positive evidence goes, this middle portion of the cerebrum, instead of being the seat of conscientiousness, hope, veneration, firmness, etc., as there located by the phrenologists, is simply the central bureau from which certain muscular movements are dictated to the system. For it is hardly to be conceived that the same portion of brain combines, for example, the two dissimilar functions of veneration and advancing the leg as in walking, or that acquisitiveness and ideality stand in some intimate relation to the protrusion and retraction of the tongue.* The merely negative results obtained from other brain tracts leave it of course open to belief that the intellectual powers and the higher characteristics of man's nature may have a local connection with those tracts; but the fact that for a large number of movements no corresponding brain region has been found leaves it at least equally probable, reasoning from analogy, that the function of the unclassified, as well as of the explored parts, is the voluntary control of muscles whose action is of the less demonstrative sort.

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* A comparison of the plates in Ferrier's *Functions of the Brain*, with a phrenological chart, will illustrate the coincidence of position here referred to.

There are two other physiological facts in relation to our subject which are too important to be passed over without remark. It was discovered by a French physician, who carefully dieted and weighed himself for the purpose, that mental work was accompanied by an appreciable waste of phosphates and sulphates. This waste he attributed to a corresponding waste of brain tissue, but his experiments did not exclude the possibility of its having taken place elsewhere. The missing link of evidence was supplied by another observer, who, by means of a thermo-electric apparatus, discovered that the temperature of the human head is increased during mental activity. A rise in temperature is a natural accompaniment of the destruction of tissue by work, just as it is of some chemical changes, and thus the latter observation thoroughly confirmed the results of the former. This second discovery again was rendered still more precise by a further demonstration supplied by yet another observer, who proved, by direct examination of the cerebral substance, that there was a local increase of heat in special parts of the brains of animals upon stimulation of those parts of the body which had been already shown to be in special connection with them.

Thus far, then, the physiological method has gone, and interesting as are its results, it is clear that it leaves us as far as ever from the quantitative psychology which we seek. Phrenology had supplied some hope of an effective induction, but vivisection has overthrown that hope. It has dethroned from their prominences high powers of intellect, and placed in their stead, and that obviously by a rightful title, certain motor relations of the body. And the fact that there is a consumption of cerebral tissue and a development of cerebral heat in the act of thinking are not only of too general a nature to help us, but they leave open the possibility that the brain simply plays, in regard to thought, the same subsidiary part which the muscle performs in regard to effort. It remains quite conceivable that in mental operations there is some impalpable and invisible agency at work which neither the dissecting-knife nor the microscope can ever have power to reveal. And independently of this consideration, we must remember that there are two physical factors the co-operation of which is essential to all cerebral changes, whatever the significance of those changes may be. The influence of the circulating fluid is as indispensable to such modifications as is the existence of the cerebral tissue, and intelligent consciousness, if allied to either, may with nearly equal probability be held to reside in either or both. The chief inference from physiology which, as it appears to me, we may safely draw, is that the brain is a true secondary battery or accumulator of nervous force, and that its folds and convolutions and general internal structure play the part of the sheet-lead and minium in a Faure element, storing up continually the energy with which the circulation of the blood incessantly supplies it.

Physiology, then, not having furnished us with such results as we are in search of, the next obvious expedient is to consider such attempts as have been made to associate with it subjective or self-observation. Something of this sort had obviously been done by the gentleman who dieted himself and studied his phosphates, but more definite results have been obtained by other observers who gave a different range to the introspective method. Thus Professor Donders, of Utrecht, by means of a machine which he invented, arrived at the conclusion that the amount of time required by a man of middle age to perform a single act of thought was about one-twenty-fifth part of a second. Block, a German observer, had already estimated the rapidity of the nerve current of the spinal cord at 194 metres per second, that of the current in the nerves themselves at 133 metres. Other investigators have arrived by independent observations at the lower rates of from 26 to 94 metres per second as the time which it takes a sensation to travel over the telegraph wires of the human system. And Fechner has been able to formulate a definite law with regard to the relative intensity of sensations, which in its final form is that the effect upon consciousness varies as the logarithm of the fundamental impression.

All these results, however, leave much to be desired, and it was, so far as I am aware, Mr. Francis Galton who first boldly released himself from physiological swaddling-bands and adopted an almost purely introspective method for the prosecution of quantitative enquiries of the desired character. His experiments are to be found in detail in his own writings, and I will now only give a brief summary of those which have yielded the more important results he has attained.

A branch of enquiry to which Mr. Galton has addressed himself is the vividness or otherwise of mental imagery in different persons. One of his experiments in this direction consisted in putting the same series of questions to a number of individuals with regard to their recollection of some ordinary group of objects. In one instance he thus selected the breakfast table. All his correspondents might fairly be supposed to have breakfasted, and each was asked to state under proper relative terms the clearness of his recollection or mental image of the breakfast table and its paraphernalia as compared with the original visual impression of the same scene.* And Mr. Galton not only succeeded in establishing the fact that there was a very great difference in different persons in this respect, but he was also able to arrive at some general conclusions which tended to show that this visualising power varied according to age and occupation in life. But the quantitative value of these observations was not very great. There is obviously considerable variety in breakfast tables, and not only would this circumstance affect the accuracy of any results attained, but it had, in point of fact, been tolerably well known before these experiments were made that great personal differences existed in this matter. Dr. Wigan, for example, in a work published in 1844,* tells us of a painter who, from the result of only one sitting, was able to paint a portrait with the utmost accuracy. He could at will, by fixing his eyes on the chair which the sitter had once occupied, call up at all future times his *simulacrum*, and paint from it as from the original. And we have it upon good authority that Charles Dickens so completely realised the favourite characters of his novels, that he felt towards them almost as if they were his intimate acquaintances.

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* *Mind*, July, 1880.

A more valuable experiment was made at another time by Mr. Galton in the following manner. He arranged a list of words, and placed it before him in such a way that by a slight effort he could just see one word at a given moment. As soon as he had seen this word, he allowed about a couple of ideas to form themselves in his mind, and then by means of a stop-watch measured the length of time which these two ideas had occupied. He then set himself to take a memorandum of everything he could remember with regard to the character and idiosyncrasy of the ideas which had thus presented themselves. Mr. Galton made use in this manner of 75 words. He went through them on four successive occasions in the manner prescribed, making thus a total of 300 separate trials. These he found to have given rise to 505 ideas in the space of 660 seconds. There were, however, many cases of recurrence, that is to say, of the same idea having arisen more than once upon the suggestion of different words, and thus the number of different ideas was only 279.*

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* *The Duality of the Mind;* A. Wigan, M.D., 1844.

These observations of Mr. Galton's came under my notice some time after a somewhat similar course of enquiry had engaged my own attention, and, whilst I appreciate the value of his novel and striking results, it appears to me that there are flaws in his methods of procedure which detract considerably from their value. As regards his mind pictures, it is evident that anything like exactness in comparing results is not to be thus attained. A form in which such experiments can be attempted by any one, and that with results of higher quantitative value, is to take a list of names of persons whom you have known well enough to be able to produce at will a mental picture of them. It is not requisite that the picture should be vivid; it is sufficient that it shall be recognisable. Then pass through the mind a number of these recognisable likenesses as rapidly as possible, and observe how many pass in a given time, which, as a matter of convenience, should not be more than a minute or two. It will be found that in this way something like fifty mental sketches per minute can be taken,† and that any increase in rate is attended with an immensely increasing ratio of difficulty. The one advantage in this species of mental presentation over that of Mr. Galton, is that you are making use, in the shape of portraits, of units of measurement which may fairly be taken as of equal value. The range of quantitative variation between faces is far less than that between breakfast tables.

A similar consideration applies again *mutatis mutandis* to Mr. Galton's second process. You will recollect that, like a member of a gun-club shooting at pigeons, he slipped a couple of ideas from a mental trap, knocked them over when fairly on the wing, and then proceeded to anatomise them. But here, as before, the unit of measurement is extremely indefinite. It is impossible to assign to ideas taken promiscuously in this way any direct quantitative value. All that we are in a position to assert is that they vary very greatly in this respect. And in so far as it is an object of the experiment referred to to ascertain the rate at which the formation of ideas goes on, it appears to me that more satisfactory results can be arrived at in a manner about to be described, but with regard to which one or two prefatory remarks are needed.

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* "Psychometric Facts," *Nineteenth Century*, March, 1879.

† This coincides almost exactly with the result obtained by Mr. Galton in the process last described.

As we have already said, ideas themselves cannot be accepted as convenient units for the measurement of mental operations, simply because they are incongruous and dissimilar, some more complex than others, and few, if any, bearing the character of true psychical molecules at all; but fortunately for our purpose all ideas possess in common a derived function, into the medium of which they may and do pass. It is clear that language is a function of this character. It is also evident that although we are certainly not in a position to say that equal quantities of language contain always equal quantities of ideas, we may nevertheless assume that such a proposition would become more and more nearly true as we take a larger and larger number of words as the basis of investigation. In the final limit, using the term in its mathematical sense, it may therefore be said that words and ideas vary simultaneously and in a constant ratio to each other. There is, of course, a colloquial sense in which we might be disposed to say that words and ideas in some men's use of them stand in an inverse ratio, but it will be found upon reflection that what we are really estimating in making such a statement is, the novelty, the originality, the logical and rhetorical value of the ideas propounded, and not their actual inherent number or efficiency as mental counters. It follows from these considerations that an estimation of the mind rate may be obtained in terms of the number of words which can pass through the mind in a given time, and that such an estimation might be made as accurate as we please by increasing the number of words operated upon.

One further proviso it is also necessary to make. Velocity or rate is, under all experimental conditions, a thing which varies constantly. If, therefore, we wish to measure the rate of anything, it is clear that we can only do so satisfactorily by taking it at its maximum. The only way, for example, by which you can for any purpose of comparison define the velocity of a shot fired from a cannon, is by taking its initial or greatest velocity. Or again, if you wish to express the speed of a particular race-horse, you take its best performances as the criterion, although it is clear that both the cannon-ball and the race-horse have, at other times than those taken as representative, other rates of speed, observation of which would be useless for the special end supposed to be in view.

It evidently follows that, in order to arrive at any useful measure of the velocity with which words pass through the mind, the result must be obtained under the most favourable circumstances. The words themselves must be so well known as neither to raise the friction of novelty nor in any other way to divert the mental force employed. The most convenient form, therefore, of making such an experiment is to take a poem, or other piece of composition, known, as the saying goes, by heart, and to read it as rapidly as is possible to the observer, taking care, however, not to slip a single word. If this is done under suitable conditions, and the time occupied by the process accurately noted, it will be found that a very constant result for each individual is arrived at, and that any attempt to go beyond this rate is most arduous, and almost certain to involve a break in the exact continuity of the reading process. About eight hundred words per minute, or thirteen to fourteen per second, is the approximate number which can be thus consciously read.

But the experiment may now be carried a stage further, by removing the book and passing the same words through the mind, in the same way as when read, that is to say, as rapidly as they can be rushed through consciousness without, however, omitting anything. A very striking result will at once present itself. However perfectly familiar the lines may be, and although there is no conscious effort whatever in recalling them, which last is of course a necessary condition for the purpose of any useful comparison, it will be found that the same matter now takes much longer to pass through the mind, the retardation being nearly equal to one-half. Thus a person who in the former experiment could pass seven hundred to eight hundred words per minute through his mind, would in the latter find himself reduced to about four hundred and fifty, and no effort whatever would enable him to increase this rate to any appreciable extent.

It is clear that this comparison supplies a differential result of importance, for which there must be some adequate cause. The first solution of it which occurred to myself was, that in the act of reading, the double character of the brain rendered possible a duplex action, whilst in the pure act of thought, the whole brain co-operated and acted singly. And this, which would accord with a theory propounded by Dr. Wigan of the *duality* of the mind; in a work already referred to, might seem at first sight to be a satisfactory explanation of the phenomenon. But it so happens that such an explanation can be at once disproved by a crucial experiment. It is clear that if there is any independent action in the two halves of the brain in the act of reading at a forced rate, such independent action must be ministered to and rendered possible by corresponding separate action in the organs of vision, each of which is directly connected with different brain hemispheres. But it will be found, upon experiment, that you can read as rapidly with one eye as with two, and thus the theory of duplex action conspicuously fails.

The retardation referred to must therefore be regarded as the equivalent of the cerebration involved in the act of recollection, unconscious as was its exertion in the assumed case.

And the equivalent thus ascertained is fixed, as is clear from the data, at a point of minimum effort, which in the case of memory is obviously also the point at which an estimation, to be of value, would have to be taken; for a minimum of exertion in recalling verbal matter necessarily corresponds with a maximum of rate, and we have already shown sufficient reason for adopting this phase of mental action as the true basis of measurement. We have thus arrived at a further quantitative expression of some value, for memory is undoubtedly the most invariable constant in our mental constitution. From the moment when the wail of the new-born infant breaks upon the ear of the smiling yet anxious faces which surround it, to that in which the hoary centenarian totters peacefully into his grave, oppressed with the snows of over a hundred winters, there is no waking instant in which it is not incessantly present in every mental combination that can be formed.

There is, it must now be remarked, some collateral evidence of the actuality of the retardation just referred to, which may readily be cited. It is usual, and probably correct, to regard those as the most powerful minds which admit of the greatest amount of concentrated effort, and it must therefore, *a fortiori*, be very safe to assume that such minds are at any rate not deficient or wanting in vigor. From all physical analogy, again, it would appear only reasonable to suppose that when the mental force is concentrated, there ought, other things being equal, to be a corresponding rapidity of ideation. Combining these two propositions, it should follow that great thinkers are also rapid thinkers. But the facts appear to lie the other way. This rapidity has certainly not been specially characteristic of men who have greatly excelled in high mental achievements. It would be at least as nearly true to say of them that the efficiency of their mental process has been in proportion to the slowness of its exercise, a fact which has its counterpart in the circumstance that men occupied in the active pursuits of life, and well adapted by the agility of their minds for such pursuits, are seldom profound thinkers. Even the brilliancy of Sheridan's wit is connected by his biographer, Moore, with the natural slowness of his mind. Descartes, perhaps the most original of philosophers, spent sixteen hours a day in bed brooding over his conceptions. Sir Isaac Newton would sit for over an hour on the side of the bed when dressing, with one leg in his nether garments and one leg out of them, a position which would be impossible to an agile-minded man. Adam Smith, one of the most original of thinkers, was so extremely absent, that the market-women thought him daft, and on one occasion he walked out of his house, out of his garden, and several miles along the road, partially clothed in his dressing-gown, and was only aroused from his reverie by meeting the people going to church.

From the general considerations with which they have just been prefaced, it is probable that in these illustrative cases, and many similar ones which will occur to you, there existed, in combination with the highly concentrated mental state, a real retardation of thought, caused by the powerful exercise of memories loaded with appropriate knowledge, and focussed upon the individual points under consideration.

In the supreme effort of contemplation, the thinking *at* a thing, by which Newton devised the principle of fluxions, and in virtue of which other great original conceptions have been formed, the mind must therefore be conceived of as almost at a standstill. It floats with a poise like that of the sea-gull on the wing, when the vigilance of the bird is at its highest stretch in quest of the finny prey glimmering under the rolling waves beneath it. A familiar way in which ordinary mortals like ourselves may produce an analogous result, is by trying to recall some name or thing we have forgotten. It will be found that the retardation produced by a determined effort of this sort, when the difficulty of recollection is sufficiently great, will bring the process of thought almost to a standstill. And these various data not only confirm the theory of retardation we have derived from another source, but also serve to show that this retardation of memory, under the phase of maximum exertion, may be looked upon as reducing constructive ideation to its zero.

The method which has been thus adopted in dealing with the mental rate of the human mind, and the questions arising out of it, would leave an element of conspicuous incompleteness were it not now briefly supplemented by some investigation of the effect produced by the familiar phenomenon of *distributed* ideation. In the foregoing considerations we have dealt with concentrated states of mind. Its normal condition is one of much less tension. It is a matter of ordinary experience that human beings are able to receive several apparently simultaneous impressions, and thus to have different ideas forming contemporaneously. A man walks along the street with his ears open to all sounds, and his eyes conveying to his brain all the sights which confront him. And without his consciousness being in the least degree veiled to these things, he may at the same time be carrying out an intelligent train of thought which has no reference to the physical circumstances by which he is surrounded. The degree to which consciousness can be thus distributed is not at present susceptible of exact definition. On *a priori* grounds, however, it is probable that it is limited by the number of the different senses with one or at most two phases over for the purely mental processes. In corroboration of this estimate, it may be remarked that it has been laid down by Sir William Hamilton that we can only retain in our minds about six ideas simultaneously. A much greater degree of proficiency in this direction is, however, claimed by certain Hindus, as the following extract from Mr. Monier Williams' writings will show. He says:—

> "During one of my visits to Bombay, he (Pandit Gattū Lālajī) called on me, accompanied by three amanuenses, and requested a trial of his powers, declaring himself capable of composing six sets of extemporaneous verses simultaneously on any six subjects and in any six metres I liked to select. I proposed three subjects—a description of Bombay, the advantage of Sanskrit learning, and the advent of the Prince of Wales to India—naming at the same time three of the most difficult metres I could remember. Without a moment's delay the Pandit dictated the required verses to his scribes with wonderful precision and rapidity. . . . Impromptu versifiers of this kind are called Sīghra-Kavis or Asú-Kavis. . . . While I was travelling in the south of India, I was visited by a Sátāvadhānī, that is to say, a man who could attend to one hundred things at once. He could play several games of chess, write and repeat poetry, work out problems, and make calculations of all kinds simultaneously. I also heard of a Trins ádavadhānī, or man who could attend to thirty subjects. . . . Ashtāvadhānīs, or persons capable of attending to eight subjects simultaneously, are by no means uncommon throughout all parts of India."

Somewhat analogous to the performance of these Hindoos is that of those European chess players who can play a number of games blindfold. Paulsen, for example, has played as many as twelve games simultaneously in this manner. But I am strongly of opinion that the case of the chess player, and also those cited by Professor Williams, are not really cases of simultaneous thought upon different subjects, but rather instances of rapid alternation of thought from one subject to another,* the memory recording each consecutive state faithfully, so that when the intermittent ideation comes round to a dropped subject, it can at once pick the clue up again at the precise point at which it was before abandoned. That some less complex combination of simultaneous ideation may go on is possibly true, but it is more probable that there is in all cases which are so regarded a real alternation of mental effort, although that alternation may be so extremely rapid as to be imperceptible.

The immediate question, however, which is essential to our subject is how far the distribution of attention, whether really or only apparently simultaneous, affects the mental rate. For a definite result, it is again expedient to appeal to a verbal standard. It will be found upon experiment that although far from being an agreeable operation, it is not very difficult to pass through the mind a certain portion of well-known verbal matter whilst at the same time engaged in reading another portion, which should of course be equally familiar. The result attained will be nearly constant in its total, but will vary considerably as to the relative quantity of each kind of matter which passes in a given time. There will be usually, as might be expected, more of the matter which is read than of that which is purely mentalised. But the total, taking each at the relative value previously indicated, will be nearly equal, for equal times, to the same total which would have been obtained by successive undivided efforts. So far, therefore, as an inference can be drawn, the area which can be gone over by *dividing* the attention is in any case no *greater* than can be traversed by successive *concentrated* efforts, whilst the conscious difficulty experienced is largely increased.

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* In the context of the above passages Professor Williams distinctly ennunciates the same view. The article from which these extracts are taken is entitled, "Indian Powers of Memory," and appeared in the *Athenæum* of March 6th, 1880.

The general theory of the rate of ideation, as investigated in the manner described, may therefore be stated thus:—

(1) That the maximum rate of each human mind is constant, and may be conveniently stated in terms of its principal derived function, that of language.

(2) That the total possible amount of ideation in a given time cannot be increased by a division of the attention.

(3) That there is a specific retardation in the formation of ideas caused by the exercise of memory and proportional to its exercise. That this retardation can be accurately estimated when in its minimum phase, and at its maximum may be taken as equivalent to an approximate stoppage of constructive ideation.

It is now time to draw this paper to a close. The data which I have placed before you are too general in their nature to lead to anything like a complete quantitative theory of mind and its activities. But in this matter we have to glean our facts where we can; the field is wide and nearly untrodden, and there is scope for many workers before its scattered harvest can be gathered.

In trying to ascertain in a definite and measurable form something more of man's intellectual nature, we stand, as Commander Markham did upon that northern promontory, from which his eye wandered over the frozen and glittering waste which lay between him and the Pole. Like him, we shall realise by arduous experience, if we attempt to traverse it, that the palæocrystic sea of metaphysics will break down our efforts with no useful result. Theologians may undertake to balloon us over the icy wilderness; but, however lofty their method, they are at the mercy of airs and currents of the human atmosphere which it is impossible to control. With patient steps and slow, we must rather follow the devious coast line of solid experiment, convinced that we shall thus reach the nearest approximation to the knowledge we seek which the imperfection of our faculties will permit us to obtain.

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* This corroborates the view expressed by Hume in the following passage. "The mind, as well as the body, seems to be endowed with a certain precise degree of force and activity, which it never employs in one action but at the expense of all the rest."—*Treatise on Human Nature*, p. 325.

ON THE JUSTIFIABILITY OF SCIENTIFIC EXPERIMENTS ON LIVING ANIMALS.

BY FREDERICK POLLARD, M.D. LOND.

THE Royal Society for the Prevention of Cruelty to Animals, whose persistent efforts to quicken the public conscience with regard to the infliction of thoughtless and wanton cruelty are worthy of all praise, began about the year 1873 to turn their attention to the subject of experimentation on animals for the purposes of scientific research, and from that time they have continued, in a fair and reasonable spirit, to protest against the abuses of vivisection, not seeking to entirely prohibit experimentation, but only desiring to prevent the infliction of excessive or unnecessary pain. As the result of a prosecution undertaken by this Society in 1874, a long discussion took place in the *Times* and the *Spectator* on the usefulness and justifiability of vivisection, a very prominent part against it being taken by Mr. R. H. Hutton, the able editor of the *Spectator*.

Very different was the character of the agitation commenced in 1875 by a Mr. George R. Jesse, of Macclesfield, and his friends, who styled themselves the "Society for the Abolition of Vivisection." This Society endeavoured in various ways to inflame the popular sentiment against physiologists. For instance, advertisements such as the following were day after day inserted in the *Times* and other papers, accompanied by the offer of a reward of twenty pounds for information leading to the detection and conviction before a magistrate of anyone engaged in the practice of vivisection :—

> "The hideous cruelty of dissecting living animals, and inflicting on them, though innocent and defenceless, multitudinous deaths of ex-

cruciating and protracted agony, has secretly grown up in this nation, a nation which for ages past has been nobly distinguished by the courageous and unsanguinary character of its people. This moral ulcer has spread widely, and (whether it be or not a dreadful form of insanity) becomes dangerous and demoralising to society, a blot on civilisation, a stigma on Christianity. The public has little idea what the horrors of vivisection are; its crimes in studied, ingenious, refined, and appalling torture, in wantonness, uselessness, and wickedness, cannot be surpassed in the annals of the world!" and so on.

I may add that Mr. Jesse has always been so proud of this unique specimen of melodramatic writing, that he still has it reprinted, and will be glad to send a copy, with other choice samples of his composition, to anyone who will write to him for them.

About the same time, also, offensive caricatures, representing men of science, with fiendish delight depicted on their countenances, carving away at poor brutes, whose attitudes and expressions were indicative of acute suffering, were placarded about the London streets. Not long after, the services of that well-known guardian of public morality, the *Illustrated Police News*, were called into requisition, and its artist reproduced, with a view to the enlightenment of the provinces, one of the most startling of those placards with which the walls of London were adorned. The public interest having been thus in various ways aroused regarding vivisection, the subject was speedily brought under the notice of both Houses of Parliament; and in 1875 the Government decided to appoint a Royal Commission to inquire into the whole subject. The Commission consisted of the following gentlemen:—Viscount Cardwell (chairman), Lord Winmarleigh, Sir J. B. Karslake, Mr. W. E. Forster, Professor Huxley, Professor Erichsen, and Mr. R. H. Hutton.

The Commissioners held twenty-six sittings for receiving evidence, and examined fifty-three witnesses, including the leaders of the medical profession in this country; some of the best-known writers on biology and physiology, such as Mr. Darwin, Mr. George Henry Lewes, and Dr. Carpenter; most of those who were known to practice vivisection; the Secretaries of the Society for the Prevention of Cruelty to Animals and the Society for the Abolition of Vivisection, together with a number of delegates from these societies, and several well-known veterinary surgeons. The Royal Commissioners presented their Report in January, 1876. They pointed out that the whole subject of experiments on animals had been relieved of the greater part of its difficulty by the discovery of anæsthetics, and that all British physiologists accepted the principle that painful operations should invariably be made under chloroform, except in the rare instances where the anæsthetic would defeat the object of the experiment. There was no reason to believe that there was any indifference to suffering, either among physiologists or students. Their conclusion was that it was neither possible nor reasonable altogether to prevent vivisection; that the greatest mitigations of human suffering had been in part derived from such experiments; but that they should only be performed by properly licensed persons, and under regulations which should insure that as little suffering as possible should be inflicted.

Shortly after this Report was issued, the Government brought in a Bill to regulate the performance of painful experiments on animals, which became law on August 15th, 1876, and is still in force. It prohibits, under heavy penalties, any pain-giving experiment on a living vertebrate animal by any person who is not licensed by the Home Secretary, or, in Ireland, by the Chief Secretary. Anæsthetics must be used throughout the experiment, and if subsequent pain be anticipated, the animal must be killed before recovery from the anæsthetic; but these latter restrictions may be relaxed for any licensee by the Home Secretary if he think fit. Other clauses relate to experiments used for purposes of instruction, and to the appointment of Inspectors.

This measure, though going further than the recommendations of the Royal Commissioners in the stringency of its regulations, was accepted with good grace by physiologists and by the medical press, which advocated loyal adherence to its regulations on the part of investigators, and deprecated further agitation on the subject. This advice, however, did not meet the views of the promoters of the anti-vivisectionist movement, who professed themselves entirely dissatisfied with the Government measure, and soon recommenced agitation more actively than ever.

It is very important that an enlightened public opinion should be formed on this important question; that calm judgment, founded upon adequate knowledge, should take the place of vague impressions or of unreasoning prejudice. I therefore venture to submit to your consideration the following facts and arguments in regard to the justifiability of experiments on lower animals, restricted within certain limits, for the advancement of scientific knowledge, and for the benefit of mankind and of other animals.

I. ARGUMENTS IN FAVOUR OF VIVISECTION.

(1) In the first place, I would observe that the subordination of the interests and lives of the lower animals to those of man is not only a principle which is universally acted upon, but is an actual necessity for the continuance of human society. By the struggle for existence, as Mr. Darwin tells us, man has attained his supremacy over all other forms of animal life, and he can only maintain that supremacy by the constant sacrifice of the lives of other animals.

If man refrained from destroying carnivorous animals, they would soon destroy him. If he were to leave off feeding on herbiverous animals, they would soon monopolise all the vegetable food, and he would have to starve. The results of protecting instead of exterminating the various forms of lower life which infest our homes by day and by night can be imagined better than described.

But it is not merely the destruction of dangerous or annoying creatures, and the slaying of animals for food, that are sanctioned by the universal practice of mankind. Men have always acted as if they had a perfect right to make any use they could of lower animals, for their own pleasure or advantage; and the principle that as little suffering as possible should be inflicted in thus using them has been very little recognised. No doubt, as civilisation advances, this latter principle becomes more generally accepted, and various painful uses to which animals have been subjected gradually die out. The public conscience becomes quickened, and demands that, at all events in the case of a few selected animals, severe pain shall not be inflicted on them without something like adequate cause. Now, the contention of physiologists is that the employment of animals for experimental purposes is not only in accordance with this generally recognised subjection of their lives and interests to those of mankind, but that such employment of them entails less suffering, and is at the same time more beneficial than many of the other uses to which animals are constantly put, and is therefore more justifiable.

I will give a few illustrations of the many ways in which animals are or have been used by men for their pleasure or advantage. In days of yore countless animals were slain in order to attract the favour or to avert the wrath of the divinities. The employment of the muscular power of animals for man's purposes, and the use of their bodies for food and in other ways, are almost universal, and at the same time much needless suffering is constantly inflicted. Various painful mutilations of several kinds of domestic animals are performed in hundreds of instances every day in this country, merely to suit the convenience or the fancy of their owners, or to increase their pecuniary value. The destruction of many kinds of animals as pests has always and rightly been considered perfectly justifiable, but the methods used to this day are often extremely cruel, such as the administration of slow and painful poisons, and the leaving of the animals to starve in gins and traps. I was told the other day by a physiologist of my acquaintance, that he was visiting a lady in the country who was a very strong anti-vivisectionist, and who lost no time in impressing her views upon her guest. Taking him for a stroll through her gardens, they soon came upon an unhappy rat which had been caught by its nose and one of its legs in a spring gin, a horrid instrument armed with teeth, in which it had probably hung for some hours and died of sheer pain. The lady remarked that she was obliged to have a number of these gins about the place, and that sometimes rabbits, cats, and poultry, as well as rats, were caught by them; but she could not be brought to see that a truly humane person, if compelled to destroy animal life, would do it by the most painless methods possible, instead of by using such horrible instruments of torture. For in fact it is simply necessary to brand any class of animals, however highly organised and sensitive to pain, with the name of vermin, and that is considered quite sufficient excuse for putting them out of the pale of consideration.

But it is in the infliction of suffering on animals for pure amusement that the claim of mankind to make use of the lower creation for his own ends is most conspicuously displayed; and a great deal has been written about the inconsistency of persecuting the scientific experimenter for his alleged cruelty, when all kinds of cruel sports are freely indulged in without reproach. I must confess, however, that this argument has never appeared to me to have much weight. The pathetic pictures which have been so often and so truly drawn about the sufferings of countless grouse, partridges, and other game, maimed by the clumsy shots of cockney sportsmen, with just strength enough left to escape capture, but who must afterwards perish miserably from their wounds or from starvation; the injuries inflicted on horses in steeple-chasing; the torture endured by the hare in coursing, with the hounds close on her heels, straining to tear her to pieces, in spite of Miss Cobbe's contention that the hunted animal is as indifferent to pain as is the soldier in the excitement of battle; the feelings of the fox from the moment he is unearthed until he is dispatched in the presence of those ladies and gentlemen who are fortunate enough to be "in at the death;" all these things seem to me to be very good reasons for inquiring whether the pains inflicted by sportsmen are justified by the advantages gained in the way of healthy exercise and pleasurable excitement; just as has already been done in the case of bear-baiting and cock-fighting, and as must surely soon be done in the case of that contemptible amusement called pigeon-shooting. But I cannot see that they afford any reason why persons who think it better to begin by attacking vivisection should be precluded from doing so until all these pain-giving sports are done away with. Cruelty by one set of people is no excuse for cruelty by another set of people; and it is no justification of physiologists, if they are cruel, that farmers, and poulterers, and rat-catchers, and angling bishops, and country gentlemen, and benevolent ladies, are all cruel in various ways, or even that they are more cruel than physiologists themselves.

While the necessities of human life demand that the life and interests of lower animals shall be held subordinate to those of man, at the same time the enlightened conscience of mankind is demanding more and more distinctly that cruelty shall cease to mark the treatment of animals by man. All infliction of pain on animals is not cruel, however; and the question, whether the use of an animal in a particular way is cruel, or not, must depend on circumstances. But I think that all candid persons must admit this, that the employment of animals for experimental purposes, and their employment for all other sorts of purposes to which I have alluded, are strictly analagous, and that the justifiability of inflicting pain on animals ought to be decided, without prejudice, on precisely similar grounds in all cases. These grounds are, in brief, the utility of the proceeding and the amount of pain inflicted. Whether the usefulness of vivisection is considerable or otherwise, and whether the pain inflicted is such as to make it cruel, and therefore unjustifiable, or not, will be considered further on. Meanwhile it may be stated that scientific men assert that, as practised in this country, the suffering caused in experiments on animals is so small in comparison with the benefits derived therefrom, that no person can reasonably condemn vivisection *in toto* who is not also prepared to maintain that mankind have no right to inflict any pain whatever on a lower animal for any selfish purpose.

(2) This brings me to the second argument, which is that experiments on animals have contributed enormously to the attainment of accurate knowledge of physiological and diseased processes, to the advancement of practical medicine and surgery, to the elucidation of the action and uses of many important drugs, and to the discovery of methods of detection of, and of antidotes for, numerous poisons; and that without such experiments further important advances in these various branches of science would be very seriously retarded, or altogether prevented; and further, that in the benefits to be derived from such experiments, many of the lower animals themselves, as well

as man, have shared and will share. I will mention a few instances of important discoveries arising through vivisection, and they may be arranged in several classes.

(A) *Physiology.*—The most cursory examination of any good text-book of Physiology will show that our knowledge of all the functions of the body, those of the nervous system, of digestion, absorption, nutrition, and secretion, of the circulation and aëration of the blood, and of the processes of reproduction, is largely based upon vivisection and other experiments on animals. And this must of necessity be so. Physiology is essentially an experimental science. It would be difficult to set a paper of questions in physiology of the most elementary kind, the answers to which would not be based upon experiments on living animals or on man. Physiology can no more advance without experiments than chemistry can.

(B) *Pathology,* or the Science of Abnormal Vital Processes.—Under this heading I may mention various investigations relating to inflammation, of which nearly all we know is due to experiments on animals; important investigations regarding the inoculability and nature of tubercle by Koch and others; the discovery of the causes of the normal and abnormal sounds of the heart; researches regarding the zymotic nature of many diseases, in some cases resulting in the discovery of preventive measures.

(C) *Practical Medicine and Therapeutics.*—Take, for instance, the discovery of vaccination by Jenner; of the usefulness of artificial respiration; and of the best measures for restoring animation in cases of drowning; the discovery of ether and chloroform as anæsthetics was largely due to experiments on animals; as was also the discovery of the value of chloral by Oscar Liebreich; Dr. Rutherford's experiments on the secretion of bile, whereby much definite information regarding the action of various drugs on the liver was obtained; and Dr. Lauder Brunton's demonstration of the effect of nitrite of amyl in reducing arterial pressure, which has been the means of affording relief in several very painful diseases.

(D) *Practical Surgery.*—In this department I may mention John Hunter's celebrated experiments on deer, which led to greatly improved methods of treating aneurism; Dr. Jones's experiments at the beginning of this century, which showed that a single thread was sufficient to control bleeding from the largest artery, whereas formerly thick cords, tapes, compresses, etc., had been used, with the idea that the coats of the vessel must not be divided. By this discovery, the danger of fatal hæmorrhage after operations was greatly reduced. Transfusion of blood from one person's veins to another's would hardly have been a justifiable operation to perform on human beings until its possibility and safety had been demonstrated on lower animals; this was done, and its application to the human subject has saved many lives. The same remark applies to the operation of making a direct opening into the stomach in order to feed a person whose gullet is closed by cancer or other disease or injury; this was first done on dogs by Blondot, and, being found practicable, has been the means of prolonging human life in a large number of cases.

(E) *Toxicology and Medical Jurisprudence.*—The discovery of antidotes to some dangerous poisons has been effected by experiments on animals, and it is difficult to see how else they could be discovered unless by accident. It is hardly justifiable to poison a man in order to see if a particular remedy will restore him; and if he has poisoned himself, a medical man is bound to use such remedies as are known to be of some use, instead of experimenting with new antidotes. But by direct experiments on animals, important results have been obtained; *e.g.*, that chloral is antagonistic to strychnia, atropia to morphia, pilocarpine to atropia, and so on. Dr. Lauder Brunton was endeavouring by experiment to find an antidote to the poison of the cobra, which destroys thousands of lives in India yearly, but under the Act of 1876 he failed to gain permission to continue his experiments. Lastly, with the sanction of Government, experiments have often been performed in support of prosecutions against poisoners, by which indispensable evidence of the poisonous properties of substances has been obtained, which could hardly have been acquired in any other way.

I fear that this long catalogue may have been to a large extent unintelligible, and must at least have been very uninteresting to my non-medical hearers. I will therefore mention a couple of recent illustrative instances of the value of experimental research a little more in detail. Among the most remarkable and best-known of recent vivisectional experiments may be mentioned those of Professor Ferrier, which have effected an extraordinary change in opinion with regard to the functions of the surface of the brain, and have already borne valuable practical fruit, helping often to a much more accurate diagnosis of the seat of brain-damage than was previously possible, and hence giving a better chance of applying direct remedies.

Professor Ferrier's first series of experiments was performed at the West Riding Lunatic Asylum, with the assistance of the Medical Superintendent of that institution, Dr. J. Crichton Browne. The experiments consisted in removing the skull-cap of dogs, cats, and monkeys, and applying a weak electric current to different parts of the surface of the brain. It was demonstrated that stimulation of certain parts invariably produced certain definite movements, for instance of the ears, eyes, mouth, jaws, tongue, fore legs, hind legs, tail, etc. It was thus possible to map out a considerable part of the surface of the brain, and to assign certain groups of movements as probably produced in certain definite convolutions. On the other hand, stimulation of certain other parts of the brain's surface produced no movements, and these are therefore probably not concerned directly with the initiation of muscular contractions. Again, after the removal of portions of the brain whose stimulation produced certain movements, the animal, when consciousness was restored, seemed unable to execute these particular movements.

These experiments were the occasion of violent attacks on Drs. Ferrier and Crichton Browne, and yet it is certain that they were quite painless. Dr. Browne said, in his evidence before the Royal Commissioners: "Anæsthetics were employed in every one from first to last. I generally administered the anæsthetic." Asked whether the animals were killed before recovering consciousness, he replied that they were in all but three cases, in which the animals were kept alive a short time to observe the effects of removal of certain parts of the brain. But it is well known that the brain, though probably the seat of consciousness, has not itself much sensibility to pain, and Dr. Browne stated that these three animals showed no signs of suffering during the brief time they were allowed to live after the operation.

The other instance I will give is one in which the lives of thousands of animals are being saved by the application of knowledge derived from experiments on a few.

You are, doubtless, all aware that vaccinia, or cow-pox, is believed to be actual small-pox, modified and mitigated by its occurrence in bovine animals, and that when it is produced in the human subject by the operation of vaccination, it protects the system from the occurrence of ordinary or human small-pox. Now, M. Pasteur, of Paris, whose researches regarding the causes of fermentation are so well known, has of late years been endeavouring to imitate the process of vaccination, and to find preventives of other diseases besides small-pox. His investigations have had reference to the infectious diseases to which domestic animals are subject; and he believes that he has discovered preventives for two very fatal fevers—viz., chicken-cholera, by which great devastation is wrought in the fowl-houses of France, and splenic fever, which causes the death of oxen, sheep, and horses in France alone to the value of about twenty million francs annually. In both of these diseases there is a development of microscopic organisms in the blood of the animal, and these organisms appear to be the media by which the diseases are conveyed from one animal to another. M. Pasteur could not find that the germs of either chicken-cholera or splenic fever produced modified diseases in other animals, analagous to cow-pox, but he discovered a most ingenious way of reducing the malignancy of the germs by a process of artificial "cultivation," as he calls it, in the laboratory. In the case of chicken-cholera, for instance, he takes a little blood from a diseased fowl and adds it to some chicken-broth, which has been previously raised to a high temperature to destroy all living germs in it, and care is taken to exclude unfiltered air. The disease-germs introduced with the blood multiply, and soon the liquid is quite turbid. After a while, a drop of this liquid is added to some fresh broth, prepared as before, and again the germs rapidly multiply. The process of cultivation in fresh portions of liquid is repeated a sufficient number of times, and at last it is found that when a little of the liquid containing germs which have been sufficiently "cultivated" is injected beneath the skin of fowls, there is a little local inflammation produced, and thenceforward the fowls are not susceptible of taking the virulent form of chicken-cholera, even when actually inoculated with its germs.

By a somewhat similar process of cultivation, M. Pasteur has succeeded in discovering a preventive of splenic fever.

To test its efficacy, fifty sheep were placed at his disposal, of whom he vaccinated twenty-five with his cultivated virus. A fortnight afterwards all the fifty were inoculated with the virus of splenic fever. The twenty-five who had been previously vaccinated were unaffected by the inoculation; the other twenty-five all died within fifty hours, "Since that time," says M. Pasteur, "my energies have been taxed to meet the demands of farmers for supplies of this matter. In the space of fifteen days we have inoculated in the department surrounding Paris more than twenty thousand sheep and a large number of cattle and horses." The value of these discoveries, which were made at the cost of a comparatively very small sacrifice of animal life and suffering, does not entirely consist in the great saving of life among domestic animals, but lies also in the good hope which they afford to patient investigators, if they are not too much hampered by legislative interference, of discovering preventives to some of those epidemic diseases which cause such a large amount of misery and of premature death to the human race.

Such, then, are the two principal arguments in favour of allowing experiments on animals to be carried on by competent persons. In the first place, it is absolutely necessary for the very existence of human society that the life and interests of lower animals should be held to be subordinate to those of man; and their employment for experimental purposes is only one case of this subordination. Secondly, the results obtained by experimentation on animals are of the greatest importance to man, and of much benefit to other animals.

II. OBJECTIONS AGAINST VIVISECTION.

I now proceed to state and to examine some of the arguments which have been urged against the practice of vivisection, and in favour of its entire abolition.

(1) The first argument is, that experiments on animals are of no practical utility whatever. Cardinal Manning, for instance, at the last annual meeting of the "Society for the Protection of Animals from Vivisection," spoke of the latter as "a detestable practice, not attended with scientific results:" and the Earl of Shaftesbury stated that "the inhuman system of vivisection was not necessary for the purposes of science." Of course, when such eminent authorities on scientific matters as the Cardinal and the philanthropic Earl make a statement of this kind, it must be received with all the respect it deserves. It would have been more satisfactory if these eminent persons had deigned to offer any proofs of their sweeping assertions; but each of them seems to have thought that his *ipse dixit* on this subject would suffice to carry conviction to all his hearers. In two, at least, of their audience this was not the case; for Lord Coleridge and Mr. R. H. Hutton both tell us that they have never believed in the uselessness of vivisection, though they consider that its benefits have been exaggerated. Indeed, in the face of the fact that scientific medicine is necessarily based upon an accurate knowledge of the processes of life, and that our knowledge of these processes, *i.e.*, physiology, is in every department largely, if not chiefly, derived from experimental researches on living animals, it is difficult to understand how any sane person who has taken the trouble to look into the subject at all can honestly assert, as the organ of the Society above named asserts, that "vivisection panders to curiosity, without doing anything for science." This sublime dogmatism has been justly likened to that of the monks who persisted in vociferating that the sun did go round the earth, and shut up Galileo in prison to prove their point. Some anti-vivisectionists, however, too wise to commit themselves to a declaration of the entire uselessness of experiments on animals, have, nevertheless, endeavoured to show that certain

important discoveries, such as that of the circulation of the blood, were not entirely due to vivisection, and would probably have soon been arrived at independently. But, as Mr. Edmund Gurney has ably pointed out, the strength of the advocates for experiments does not rest entirely in startling discoveries, of immediate application to practice, but—

> "In the enormously different attitude in which a doctor stands to his patient, on the intelligence of treatment which is hard to particularise only because it is so widely ramified. . . . It is not the knowledge that this will cure this, or that the other, but the clear picture of a number of processes which suggests and modifies treatment in innumerable ways. . . . That such a picture could exist but for experimental physiology is hardly pretended, though it may exist perfectly in the eyes of a man who has never seen a single considerable experiment."—*Fortnightly Review*, Dec., 1881, p. 794.

(2) The second argument against vivisection is that it is cruel; some objectors being satisfied with this simple statement, others asserting that the suffering inflicted is not justified by the results obtained.

In the first place, then, it is constantly alleged, especially in ordinary conversation, that vivisection is wrong because it is so cruel; as if all infliction of pain were cruel without regard to the circumstances under which it is inflicted. And yet a moment's consideration will show us that the cruelty of an act depends not on the act itself, but on the state of mind of the person who does it, and on the inadequacy of the motives which actuate him to do it. Those parents who believe in the efficacy of corporal punishment as a means of training the childish character cannot be charged with cruelty unless the ungoverned irritability of their own natures leads them to inflict pain which is disproportionate to the offence committed. A rider who violently spurs and whips his horse merely to enjoy unusual rapidity of motion, is cruel; but the man may lawfully apply much painful stimulation to his horse in order to escape from a rapidly advancing tide, which threatens to engulph them both. I need not multiply instances of this kind. The distinction between pain-giving which is cruel and that which is not cruel is sufficiently obvious.

It is not enough, then, to urge against experiments on animals that they give pain, nor even that they inflict it upon the helpless and the unoffending. To establish the charge of cruelty, it is necessary to prove one of two things; either that the experimenter takes actual pleasure in causing and witnessing the sufferings of his victims; or else that the amount of pain inflicted is disproportionate to the results likely to be attained.

As regards the first point, none of the more reputable opponents of vivisection have thought fit to accuse experimenters of deriving pleasure from the actual sufferings of the animals experimented on. The grossness of such a charge would only weaken the cause it was meant to support. A scientific training and a thirst for knowledge do not tend to make a man low and brutal in his tastes.

Some writers, however, try to prejudice the question by asserting more or less explicitly that there is something peculiarly objectionable about the pains inflicted by the vivisector, inasmuch as they are deliberate, or "cold-blooded," as they say. This kind of argument is really only intended to throw dust in our eyes, and to divert us from the real question. The fact that whatever pain is inflicted by a physiologist is caused after careful deliberation and preparation, and not in an impetuous and hot-headed manner, is a reason for commendation rather than for blame. The more deliberate a man is, the less likely is he to do an experiment on inadequate grounds, or with insufficient preparation and precautions against unnecessary suffering.

The really important question is whether the amount of pain inflicted by experimenters is justified by the results obtained or likely to be obtained.

In order to judge fairly upon this question, certain preliminary points must be noticed.

In the first place, is an operation on an animal attended by as much pain as it would be in a man? This is not an easy question to answer. As regards the mere sensitiveness of the skin and other structures to pain, I am not aware that there is any distinct proof that horses, dogs, or cats are less sensitive than we are. But there is an intellectual quality in many kinds of pain that must not be lost sight of, and which greatly adds to their intensity. It depends on the power of imagination. Just fancy, for instance, a very nervous person, who had just read Miss Cobbe or Mr. Jesse on the horrors of vivisection, being handed over, bound hand and foot, to be experimented upon by a company of physiologists. The poor man would probably die of fright if he were simply pricked with a pin! It is well known that, before the days of chloroform, nervous patients about to undergo operations sometimes died of sheer fright at, or even before, the first touch of the knife. It is obvious, I think, that a cat or a dog would have none of this imaginative element added to his physical pain, any more than a baby would. This suggests another illustration. I have vaccinated many hundreds of babies. Most of them did not even cry during the operation. Those that did were soon pacified by having their attention distracted by a bottle or otherwise. The little pain inflicted was not augmented by any imaginative element. I have also vaccinated a good many grown men and women; and out of the number a considerable proportion, mostly among the men, actually fainted away. This result was not due to the amount of pain inflicted, but to the intensification of it by the imagination, and by concentration of attention. It is useless, therefore, for Miss Cobbe to try to persuade us that a rabbit or a guinea-pig laid upon a table and operated upon, even without chloroform, would suffer anything like as much pain as she herself, or her less strong-minded friends would do, under like circumstances.

The next point to which I will allude is one which was placed in the fore-front by the Royal Commissioners in their Report, but which is, for the most part, carefully ignored by the advocates of the abolition of vivisection—I mean the use of chloroform and other anæsthetics. The Commissioners stated emphatically that the whole complexion of the subject had been altered by the discovery of these agents, and that there was abundant evidence that they were constantly used by British experimenters. This employment of anæsthetics, which had previously been adopted voluntarily, became compulsory by the Act of 1876; and yet the writers against these experiments persist in treating of the subject as if there were no such thing as chloroform in existence, or its use in the laboratory were unknown. In Lord Coleridge's recent paper, for instance, there are constant references to "tortures," "agonies," "hateful cruelties," etc., but not a single allusion to the circumstance that pain can be, and is, almost entirely prevented by the use of anæsthetics. In face of the fact that chloroform is almost invariably used in every painful experiment in Great Britain, I cannot but look upon the deliberate ignoring of this by anti-vivisectionist writers as, to say the least of it, somewhat uncandid.

The last preliminary point is the great difference that exists between the usage of English and foreign physiologists in regard to the amount of pain inflicted in experiments. The popular indifference concerning the infliction of pain on animals in many continental countries is only too well known; and it is to be feared that foreign scientists, to some extent, share that popular indifference; but that English experimenters are indifferent or careless with regard to the pain they inflict is utterly untrue. This marked difference in humanity between British and continental physiologists was strongly insisted upon by the Royal Commissioners in 1876; but, curiously enough, it is constantly ignored by writers against vivisection. They persist in quoting horrible operations performed in continental laboratories, most of them years ago, and trying to lead their readers to believe that these are the sort of things that are dailybeing perpetrated here in our midst, under the sanction of an Act of Parliament. But, as a matter of fact, English physiologists have been as indignant as Lord Coleridge and Mr. Hutton in condemning the cruelties inflicted in certain foreign laboratories; and I shall show immediately how little excuse there is in the experiments of English investigators for the blood-curdling descriptions and terrible accusations with which anti-vivisectionist writers endeavour to inflame the feelings of their countrymen against our physiologists.

Having, then, cleared the ground by these preliminary considerations, the question is narrowed down to this: whether the amount of pain inflicted by British experimenters, under present regulations, is justifiable by the results obtained or likely to be obtained.

In order to be able fairly to answer this question, we must have some idea as to how much suffering is thus inflicted; and to this end we can refer to the official returns of the Inspectors appointed under the Act of 1876. I will give a brief summary of the last two Reports.

It will make the following details more intelligible if we remember that, under the Act of 1876, the holder of an ordinary license is required to render the animal wholly insensible during the operation, and to kill it before recovery of consciousness if there is likely to be any subsequent pain. Licenses under special certificates may allow experiments without anæsthetics, or may permit the animal to be kept alive for observation after the experiment.

During the year 1879 about 270 experiments were performed by persons holding licenses. The Inspector writes as follows :—

> "The number of experiments in which there is reason to believe that any material suffering was caused appears, from the statements received from the operators themselves, and from my own consideration of the nature and probable effects, as regards the production of pain, of the experiments under the certificates, to have been about twenty-five. Of these, fifteen were cases in which disease followed the inoculation of infectious matter, but in which no painful operation was performed; and ten were experiments upon as many frogs, in which an incision of the skin was required for the introduction beneath it of a medical substance. In none of the other experiments under these certificates, as I am assured by the experimenters, was any appreciable suffering inflicted. As in all other experiments except those done under the above certificates, the whole proceeding is conducted whilst the animal is in an unconscious condition; no pain is inflicted if the provisions of the Act are duly observed, and this there is no reason to suppose is not in all cases carefully attended to."—*Brit. Med. Journal*, 1880, vol. i., p. 967.

During the year 1880 the total number of experiments performed under licenses and certificates was about 311. The Inspector says :—

> "The only experiments in which there is the least reason to believe that any appreciable suffering would be caused are among those enumerated under certificates permitting experiments without anæsthetics, and under certificates dispensing with the obligation to kill the animal before recovery from anæsthetics. Under the former head the total number of experiments was seventy-nine, of which, however, sixty-nine consisted in simple inoculation (no more painful than ordinary vaccination), which in thirty-eight cases was followed by no ill effect whatever. But in about thirty instances, viz., nineteen guinea-pigs and ten or twelve mice, disease appears to have ensued, which, during the brief period the animal survived, may have caused

slight suffering. In the remaining ten experiments under the certificate, either no operation of any kind involving pain was performed, or one consisting merely in the passage of a needle through a fold in the skin of rabbits, and attended with no more pain than would be thus caused. In the thirty-five experiments performed under certificates of the other class, eighteen also consisted in simple inoculation, or the hypodermic injection of morbid secretions, with the view of tracing the development of morbific germs in the blood; and no painful effect from the proceedings appears to have been produced during the two or three days during which the animals were kept alive. In the remaining seventeen cases, in which incisions through the integument were required, as these, which constituted the only painful part of the proceeding, were made under anæsthesia, and the animals afterwards suffered nothing beyond confinement until the wounds healed or until killed, no appreciable suffering can be said to have been inflicted. All the other experiments were performed on animals previously rendered insensible, and were necessarily painless."—*British Medical Journal*, 1881, vol. ii., p. 55.

Referring to the sixty-nine cases in which inoculations were performed under certificates of the first class, Dr. Gerald Yeo remarks that twenty-nine were undertaken at the request of the Royal Agricultural Society, in order to endeavour to elucidate the disease known as "anthrax," or "splenic fever" of cattle and sheep. The other forty were performed under the direction of the Medical Department of the Local Government Board, during an investigation into a serious and frequently fatal malady known as "wool-sorters' disease," from which many persons at Bradford and other seats of the woollen manufacture have suffered, but of which, until lately, the real cause was unknown. The above investigations have shown that it is in reality identical with the splenic fever of cattle, and that it is almost certainly caused by the handling of wool of animals who have died of this disease. The practical application of this knowledge is obvious, for the disease will now be preventible by submitting the wool to a suitable process of disinfection before the work of sorting is commenced, or by inoculating the wool-sorters with Pasteur's cultivated virus.

Such, then, is the sort of experimental work which is being carried on in Great Britain to-day, and if we apply to it the tests which we laid down as distinctive of cruelty, we must, I think, unhesitatingly conclude that it is not cruel. There is no carelessness or indifference with regard to the amount of pain inflicted; still less is any pleasure derived from the actual infliction of pain, which is but a rare incident in the work of the practical physiologist in England; and when it is necessary to cause any, every precaution is taken to reduce it to a minimum. On the other hand, the importance of the results which are being worked out is very great, and the benefits likely to accrue both to mankind and to lower animals are considerable. When we consider the comparatively small amount of suffering which most of these experiments cause, and its resemblance to the common, every-day pains which most men and women have to suffer at one time or another, the pains, for instance, of a short-lived fever or a rapid consumption, one cannot help being astonished at the amount and strength of the abuse which is being hurled against those who patiently and unselfishly, regardless of obloquy and misrepresentation, carry on these investigations. In reply, then, to the objection against vivisection that it is cruel, I would submit that, at all events, as practised at present in this country, it is not cruel, since the amount of pain inflicted is abundantly justified by the benefits derived; and I further submit that it is wholly undeserving of the agitation for total abolition with which it is assailed.

(3) The last objection urged against vivisection is, that it is demoralising, both to those who practise it, and, through its being legalised, to the community at large.

As regards the moral degradation alleged to be exercised upon the physiologists themselves, it would be obviously no proof to say that vivisection must demoralise the experimenter *because* it is cruel; for the fact of its cruelty is the very point in dispute. To substantiate this objection, the opponents of vivisection would have to show that physiologists are conspicuously cruel in their ordinary life, apart from their professional pursuits. But this they have certainly not even attempted to do. I myself have known several men who have been in the habit of performing experiments, but I have entirely failed to detect any evidence of moral degradation in them. On the contrary, they have been men of high character and of wide sympathies.

As regards the demoralisation supposed to be exerted on the community at large by the fact that experiments on animals are legalised, thereby, as it is alleged, setting a conspicuous example of deliberate and lawful cruelty, I will again quote the able Editor of the *Spectator*. Mr. Hutton says that, because we legalise vivisection on account of its benefits to mankind, we deprive ourselves of any standing-ground from which to argue with a brutal wagoner or a cruel rat-catcher, who inflicts a vast amount of needless pain, and excuses himself on the ground that the end justifies the means.

Mr. Hutton appears to forget, however, that, as far as the wagoner is concerned, if he is not amenable to argument, he is at all events amenable to law. And, as regards the rat-catcher, I think it is quite time that an Act were passed to prevent, not only the professional rat-catcher, but the gin-setting lady to whom I before referred, from using needlessly cruel and barbarous methods of destroying animals. And I would go further, and say that the country parson and the squire should not be allowed, as they are at present, to inflict an unlimited amount of suffering for the sake of sport; for it is our sportsmen, and not our physiologists, who set a public example of indifference to the amount of animal suffering they cause. To return to the wagoner. Both he and the licensed scientific experimenter are subject to stringent regulations with regard to the infliction of needless pain. There is this difference, however, that wagoners are constantly being punished for cruelty to their horses, whereas our physiologists loyally conform to the regulations under which they perform their experiments. I believe that no licensed scientific man has ever been prosecuted for infringing the stipulations of the Act of 1876.

So far, then, from the labours of physiologists being an encouragement and a stimulus to cruelty, "a new impulse to the selfishness of men in every other grade of life," as Mr. Hutton says they are, I maintain that scientific experimenters, in this country at least, show an example of considerateness and self-restraint in regard to the infliction of pain on animals which persons in other grades of life would do well to imitate. I would therefore suggest to anti-vivisectors that they should now turn their attention to other and less excusable forms of animal suffering, and that, instead of abusing physiologists and accusing them of setting an example of cruelty which demoralises society, they should hold them up as examples of men who, being obliged by the necessities of their vocation to inflict a certain amount of pain on lower animals, use every precaution and care to render this as small as possible.

I therefore entirely fail to see that the fact of thoroughly trained scientific men being allowed, under careful restrictions, to perform painful experiments on animals, can in any way tend to demoralise the public, any more than does the fact that surgeons are allowed to perform painful operations on human beings. On the other hand, I am of opinion that some of the more reckless of the agitators for the abolition of vivisection have been lead, through excess of zeal for their cause, into using methods of promoting this which must be exceedingly demoralising to themselves. As an illustration of this, let me quote a passage from a leading article in the current number of the *Zoöphilist,* the organ of the Anti-vivisection Societies. Mr. Sampson Gamgee, a well-known surgeon of Birmingham, has recently written a pamphlet, in which he sets forth some of the principal improvements in practical surgery for which we are mainly, if not wholly, indebted to experiments on animals. This is what, in consequence, the *Zoöphilist* says of him :—

> "But to Mr. Gamgee . . . . the bloody rites of the physiological torture-chamber are a joy and a delight. Let weaker natures shrink and shudder at the cruelties they feel bound in stern self-denial to inflict. In his nostrils, the blood of the living sacrifice is sweet. And as his victim writhes in the slow agonies of the devouring flame, he clasps his hands in rapture, and greets the lurid glare with the Christian hymn, 'Lead, kindly Light!'"—*Zoöphilist,* March, 1882, p. 213.

That anyone could stoop to publish such trash as this is a signal illustration of the demoralisation produced by excessive zeal in the *anti*-vivisectionist cause.

III. AMOUNT OF LIMITATION DESIRABLE.

Lastly, I wish to refer briefly to the question as to the limits within which experiments on animals are justifiable, and as to what restrictions, if any, should be placed on their performance.

Several such limits have been proposed. Some writers, such as Lord Coleridge and Miss Cobbe, advocate entire prohibition of all such experiments. Mr. Hutton, probably the best-informed and at the same time the most fair of the opponents of vivisection, would draw a line on a somewhat fanciful principle. He asks us to imagine ourselves in the power of a race of beings as much above us as we are above cats and dogs. We ought, he says, to exact from lower animals only as much pain and sacrifice for our benefit as we should be willing to render to the higher race of beings for their advantage. This method of obtaining a limit, however, is far too subtle, and the limit arrived at would differ so greatly in different persons according as they possessed more or less of a martyr's spirit, that it is clearly inapplicable as a practical rule.

Of what may be called theoretical limits as to the amount of pain which it is justifiable to inflict upon animals, that proposed by Mr. Edmund Gurney is, perhaps, the most satisfactory. He lays it down that "a large amount of suffering in the future course of life on this planet being unavoidable, the amount is to be made as small as possible; therefore of any two alternative amounts, the lesser is to be chosen."—(*Loc. Cit.*, p. 784.) On this principle he justifies painful experiments on animals, provided there is reasonable expectation that the solution of the problem in hand will lead to the alleviation, either in mankind or other animals, of more suffering than that actually caused by the experiment. On the other hand, he would condemn painful operations performed simply to see what will happen, and without any distinct problem to solve; also, all repetitions of painful experiments to demonstrate well-established facts, or to illustrate lectures, or for the purposes of instruction. In all these points I agree with Mr. Gurney, and also in his further position, that there are some kinds of pain of so intense a kind that they cannot be weighed against a much larger quantity of ordinary pain. For instance, it would be better for all the world to suffer from face-ache for a night than for one man to pass it roasting over a slow fire. Applying this to the subject of experiments on animals, there are some imaginable which would be so painful as not to be justified by any merely potential advantage—nor by anything, in fact, short of the absolute certainty of their resulting in the prevention of a larger quantity of equally acute suffering. Practically, such certainty it is impossible to predict for any experiment. Consequently, I hold that to inflict very extreme and prolonged suffering is not justifiable at all. I consider that some continental vivisectors have inflicted tortures which would have been utterly inexcusable even if the benefits to be derived therefrom were likely to be very considerable, but from which, as a matter of fact, the results obtained were exceedingly trivial; and while, as I have said before, I think anti-vivisectionist writers have tried to produce an impression in the public mind that the same sort of things are being done in England to-day, on the other hand, I think the defenders of vivisection have been very unwise not more prominently and more strenuously to condemn the cruelties which have been perpetrated in the interests of Science in France and Italy. And although I believe that the sympathy of Englishmen, as a class, for lower animals is so great, that under no circumstances, whether there were legal restrictions or not, would gross cruelties be practised in this country by really competent experimenters; still, much needless suffering might be inflicted on animals by the clumsy experiments of incompetent persons if there were, what Mr. Hutton so grimly calls, a "free vivisection table." I therefore thoroughly approve of the practice of vivisection being restricted to licensed persons; and no person ought to receive a license who has not had such previous training as would ensure his being competent and skilful.

Further, I agree with the principle of the Act of 1876, that it should not be left altogether to an individual physiologist to determine how much suffering it is justifiable to inflict in order to solve a given problem; at all events, in those exceptional cases where it is proposed to cause a considerable amount of pain; nor do I think that the majority of practical physiologists would object to submitting their proposals for experiments to a suitable authority for approval before carrying them out.

There is one absurd feature of the Act, however, viz., its leaving the Home Secretary to decide, without recognised skilled assistance, on the propriety of granting or suspending licenses, and on the relative importance of suggested investigations relating to such highly technical matters as the problems of physiology and pathology.

There can be no doubt that the Home Secretary ought to be relieved of his duties in relation to the Act of 1876, or, at all events, if he retains his responsibility as administrator of the Act, the investigation of the claims of persons to receive licenses, and of the justifiability of all proposed experiments which would be likely to give any material amount of pain, should be in the hands of a competent Board of Administration.

I cannot now discuss how far the details of the Act require amending. My impression is that its regulations are too complicated and its methods too cumbrous; but that is a small matter compared with the necessity for the Home Secretary being either replaced by, or associated with, a suitable Board for administering the Act in detail. If a Board of this kind could be so constituted that both the medical profession and the public would be satisfied to leave in its hands the regulation of scientific experiments on animals, it might be fairly hoped that the subject of vivisection would be allowed to subside into quietude; that the various anti-vivisectionist societies would cease to be able to extract from an emotional but unreflecting public that pecuniary pabulum which the prolific character of their literary productions must require; and that those who have the talents and the opportunities of carrying out researches in practical physiology, or in experimental pathology, which has been rightly described as "the youngest and most brilliant branch of medical science," might do so without exposing themselves to be held up to public reprobation as heartless torturers, or their experiments to be described in widely-disseminated pamphlets as "the bloody infamies of the vivisecting trough."

It might be fairly hoped, too, that the subscribers to hospitals would no longer be bullied into withdrawing their subscriptions because one of the members of the medical staff might hold a license to perform experiments; and that ladies would be able to advertise for strayed dogs without being inundated with nauseous stories about the horrors of vivisection.

Such devices are utterly unworthy of an honest desire to settle an important question of practical morality; and however much my hearers may differ from me in their conclusions regarding the justifiability, under restrictions, of scientific experiments upon living animals, I trust they will, whenever occasion may arise, do their best to discourage all unfair methods of appealing to the passions and prejudices of people rather than to their sober reason; for, in the long run, the question will have to be settled "on the best and surest foundations," viz., accurate knowledge and dispassionate judgment.

THE PRIMARY COLORS.

ABSTRACT OF PAPER READ BY G. H. MORTON, JUN.

OF all the interesting phenomena concerning color, resulting from recent scientific researches, probably the hypothesis that red, green and violet are the three primary color sensations, attracts most attention, because of its apparent antagonism with the fact that red, yellow and blue are the three primary colors of pigments.

All colors are really sensations, caused by the action of light on one of the divisions of the retina, the so-called layer of rods and cones. It has only recently been discovered, however, by Professor Max Schultz, that both the rods and the cones have each their peculiar function, and though probably both serve as elements of light, it is more especially the function of the rods, whilst the perception of color is due, possibly exclusively, to the cones. These cones appear to be divided into three sets; one set being stimulated by the strongest vibrations of light produces the sensation of red, another set acted upon by the vibrations of medium strength produces green, and the third set responding to the short and weak vibrations produces the sensation of violet. Red, green and violet are therefore termed primary colors. Intermediate vibrations affect two sets of cones simultaneously, and consequently produce compound or secondary colors. Upon the three sets of cones being excited together, in their proper proportions, the sensation of white is the consequence. If this theory be true, we may assume the existence of a color-sense wherever we find the cones, and to mark it absent wherever they are absent. A defect in their arrangement probably accounts for color-blindness. It is well known that color-blind persons are usually insensible to the stronger, red-producing, vibrations, though cases occur when they are blind to other colors and keenly sensible to the red; indeed, the partially color-blind, as a rule, appreciate more intensely the colors they are able to perceive than persons possessing the normal sense of color. The number of persons affected, more or less, with color-blindness is surprising; according to Professor Rood it has been estimated that in England about one person in every eighteen has an imperfect color-sense, though it is remarkable that the affliction is almost exclusively peculiar to the male sex, women being comparatively free from it. Often the color-blind are for years unconcious of their defect, and it is very difficult to demonstrate the fact to them. When we consider the theory of the rods and cones, and are aware that a slight difference in their arrangement causes a proportionate difference of color-perception, and knowing that we are all subject to a slight difference, it would appear probable that each individual is affected by the vibrations of light to a different degree, or, in other words, that possibly no two persons see colors exactly alike.

Color combinations may be demonstrated in different ways; perhaps the simplest is by employing two lanterns, and projecting colored light from both on to a white screen. The two color-discs, when superposed, produce one color; the sum of the two separate discs. Taking the primary colors, red and green produce the sensation of yellow; red and violet produce pink; green and violet produce greenish-blue.

The resulting colors, yellow, pink and greenish-blue, are the secondary colors, and it follows that the brightness, or lightness, of any of these colors must be greater than that of any of the primaries, because of the nearer approach to white caused by the combination; yellow, for instance, will be as bright as the brightness of red and green added together; white will be as bright as the brightness of the three primaries added together.

The different vibrations of which white light consists are capable of producing every possible color sensation, yet we cannot say that all color is due to them alone. Were it not for the power which natural bodies have of selecting their own particular color, or rather color-producing vibrations, the phenomena would be incomplete. No natural body creates color; it simply absorbs a part of the light thrown upon it, and rejects the remainder. It is the portion so rejected, and not that retained, which determines the color.

Intercepting the white beam of light from the lantern by red glass, we prevent the vibrations which produce the sensations of violet, blue, green and greenish-yellow from passing through. The red glass absorbs all these rays; consequently the red rays alone are left, and we have a red disc on the screen. We will now from our second lantern project a greenish-blue light, this color being as nearly as possible the sum of the colors absorbed by the red medium. By moving the lanterns in order that this color may be, as it were, superposed, or added, to the red, we produce white, thus proving that the red glass had absorbed all those rays of which the bluish-green consists, and these rays had only to be given back to reproduce the original white disc. Repeating this experiment, but with blue and yellow lights, white is also produced, and not green, as might be expected from our experience of the result obtained by a mixture of blue and yellow pigments. By passing a beam of light through the blue and yellow glass *together*, placing both colors in the one lantern, green is produced, because the blue and yellow glass are not only transparent to their respective colors, but also to the green, which is contiguous to both; but the blue glass absorbs the yellow and less refrangible rays, and the yellow glass absorbs the blue and more refrangible rays, consequently green is the only color left to pass through both, and therefore when a beam of white light goes through these colors together, green is the only possible result. This is exactly what occurs in the mixture of pigments, and it is through the confounding of the mixture of lights and the mixture of pigments that many erroneous conclusions are arrived at.

So far absorption has been considered in connection with transmitted light; we have now, in order to show its connection with the colors of pigments, to consider it when combined with reflected light. The coloration of pigments, of flowers, of green leaves, indeed of all natural bodies, "is due to the combination of reflection with the phenomenon of absorption." * I have here a colorless glass vessel, containing a red solution, and of course it exhibits the same phenomena as colored glass; it requires light either transmitted or reflected to be seen, for when placed in front of the black screen it appears dark and colorless. By placing a white object in the solution, we notice that part of the light directed upon it undergoes absorption whilst passing through the fluid, and the portion left is reflected by the object, and passes back again to the eye. This light, therefore, has itself gone twice through the fluid, or double the distance of the object from the front surface of the glass vessel. It is evident that our red color is due to what is called "selective absorption," red being the only color not devoured, as it were, by the fluid. We will now add to the solution some powdered chalk, each particle of which may be regarded as a minute white object

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* Stokes.

reflecting a small quantity of the light not absorbed; all I have said of the one white object applies also to these minute particles. All color pigments are composed of such minute objects, mixed with a vehicle which has the power of sifting the white light shed upon them, and selecting certain rays, whilst the particles reflect the remainder. The condition of the petals of flowers and of green leaves is just the same. A white lily, for instance, if it were quite smooth, would have the appearance of thin glass; it is, however, composed of a vast quantity of minute cells, so that it resembles finely-powdered glass, from each little particle of which light is reflected backwards and forwards, and there being nothing in the lily to cause the selection of one ray over another, the light is white. A scarlet geranium is similarly composed, but its particles, or cells, are infused with colored matter, which absorbs the green and blue rays, and the unabsorbed scarlet is reflected. All green leaves owe their color to the same cause; light passing backwards and forwards through a coloring matter which extinguishes the red rays, is received upon the retina as green.

A property of absorption, not only interesting, but of some importance to colorists, is the change of hue colors undergo when deepened or lightened. Each additional layer of a colored medium naturally absorbs more of the light not actually destroyed, and therefore deepens the color, until at last it, too, is altogether extinguished. Light, however, has been shown to consist of vibrations of different degrees of strength; this being the case, the stronger vibrations will continue to act after the weaker are quenched; or as the color deepens its hue alters. To explain this more clearly, I will quote from a lecture by Professor Stokes, F.R.S., who, for the sake of simplicity, presupposes two kinds of light, blue and red, having intensities respectively of 100 and 10. "There is, of course, a great predominance of blue over red.

Now suppose in passing through a stratum of a certain thickness half the blue light is lost, and only half transmitted, and that ninety per cent. of the red light is transmitted. Then after passing through the first stratum the intensities will be respectively 50 and 9; after passing the second stratum of the same thickness, the intensities will be 25 and 8·1; after the third, 12·5 and 7·3; after the fourth, 6·2 and 6·6, or about equal; but after passing through the next stratum they will be 3·1 and 5·8; so that although the quantity of red light was so much smaller to begin with, the red is more lasting, and in light which has passed through five of these strata the red now predominates over the blue." I have here a glass vessel containing water; by adding a little red fluid you will perceive it has a blue hue, but by adding still more of the color, it assumes a scarlet hue. The cause is evident; at first the weaker blue vibrations were able to pass through, but when the absorbing liquid became more dense, the stronger red vibrations could only make their way. Conversely with this effect is the result obtained by the addition of white to a color pigment, for in this case the effect should be towards a hue of the more refrangible rays of blue and violet. The diagrams are colored with crimson lake, dark Brunswick green, and Prussian blue; these colors all show a decidedly bluer hue when mixed with white than would have been expected from the pure color.

I have shown that the primary sensations of color, red, green and violet, cannot be produced by the combination of any of the other color rays of white light, but that conversely all the other sensations of color are obtained by these three colors in different proportions. The same may be said of the primary colors of pigments. Red, yellow and blue cannot be produced by the mixture of other color pigments, but these colors are capable of producing by admixture almost all other colors. It will be at once evident that the colors of each set are different, the primary green and violet sensations being substituted by yellow and blue as primary color pigments; and this substitution causes one to enquire whether the remaining primary of light, red, is of the same hue as the primary pigment of that name? It is here desirable to point out the very general idea the names of colors convey to the mind. When we say red, what do we mean? The term red is often applied to a color that may be almost orange on the one side or violet on the other, green, commonly speaking, may be almost yellow or blue, violet may mean almost pink or blue. I consider that there is as much difference in the primary red of the spectrum and the primary red pigment as there is between the green light and the yellow pigment, or between the violet light and the blue pigment.

Now, the primary red of light is a scarlet red; indeed, in some works the term scarlet has been applied to it. The green light is more inclined to yellow than blue, and the violet light is a decided blue violet, and has been named blue by some writers. In pigments we find that the primary colors are the reverse of this. The best red pigment for the mixture with the greatest number of other colors is a crimson red; the best yellow is more inclined to orange than blue; the best blue is of a green hue. When these pigment colors are lightened by the addition of white, there is obtained, perhaps as near as it is possible to obtain with pigments, the secondary colors of light. It would thus appear that the colors which were formerly considered primary colors, are really the secondary colors of light, and therefore, though red, yellow and blue may be the primary colors of pigments, they are certainly not primary color sensations caused by the vibrations of light.

THE REVISION OF THE NEW TESTAMENT.

BY J. BIRKBECK NEVINS, M.D. LOND.

THE Revised New Testament in English is the result of above ten years' unintermitted labour by a Company, consisting of twenty-eight distinguished Greek and Biblical scholars in our own country, and nineteen eminent scholars in America. Seven of these have been removed by death during the progress of the work, and three have resigned.* Of the twenty-three English scholars who have continued to the end, sixteen have, on the average, attended each meeting, and the total number of meetings has been above 400 (407), † which lasted generally from 11 a.m. to 6 p.m. The American scholars have co-operated with the British Company by means of correspondence, which has been kept up throughout, no changes having been made without being first submitted to the consideration of both companies. As the result of this labour and learning, the Revised New Testament has been produced, and the limited number of points upon which the American and English Companies did not eventually agree is stated in an appendix, which is, however, so small, that the work may be considered as having been agreed upon substantially by the distinguished men who have been engaged upon it. In saying this, however, it is to be borne in mind that the result is the work of a majority of two-thirds in favour of change, over one-third or less who were opposed to it; and as the division lists are not known, critics are unable to judge whether the majority in every case contained the greatest amount of scholarly acquaintance with the subject, or only the greatest number of votes—a point this which is dwelt upon as being doubtful by some of the critics who have reviewed the work.

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* Newth, "On Bible Revision," pp. 109, 110, and following.

† Newth, p. 125.

In attempting to review a work presented to us with such claims to acceptance, a writer who can make no pretension to be considered an authority upon questions of difficult scholarship, approaches his task with a sense of responsibility which is almost painful, and he feels that the greatest modesty of expression is the most becoming attitude for such an one to adopt. But when a work is put forward like a revision of the New Testament, which has been the inheritance, the pride, and the solace of the English-speaking world for nearly three centuries, and we are called upon to accept this new work as the substitute for what we have so long treasured, even those who may not claim to be scholars are inevitably compelled to form some opinion in favour of the old or of the new. And further still, when distinguished advocates and opponents of the changes that have been made, have placed their arguments before the world, and have thus invited a judgment to be formed between them, it will not, I trust, be presumptuous to lay some of their reasons before this Society, and endeavour to assist in supplying materials for the judgment which must eventually decide whether this new work shall be adopted as *the* English New Testament, or the verdict shall be that upon the whole the Old is better. It may be fairly noted also that an English ear, though with no classical knowledge, may be as capable a judge of agreeable, and therefore good, English as the most accomplished Greek scholar; and an English audience is perfectly competent to judge of what is displeasing to the English ear, although the translation of the foreign words may be more literally correct than that idiomatic rendering which is more pleasing and intelligible to the native perception.

Objections to its English.

Upon this point—that of its English—there is an almost universal consensus of condemnation of the Revised Version. The criticisms, great and small, have been "legion," and there is scarcely one that has not condemned the changes in the Revised Testament as having spoilt the English of the version. This has been done in many ways, but perhaps more frequently than in any other, by altering the arrangement of the words in a sentence, and translating them as they stand in the Greek, instead of in the order natural to the English language. It is common in some languages to put the verb near the end of the sentence, while in English it is generally put near the beginning; and while the sentence, "There came wise men from the East to Jerusalem," is in accordance with the national habit, the change in the Revised Version to "Behold, wise men from the East came to Jerusalem," is a transposition which is not pleasing to the ear, and has nothing to recommend it, except that it gives the words in the order in which they come in the Greek. This is one of those innumerable changes which were not called for by "faithfulness," and which certainly cannot plead "necessity" as their excuse.

Another change which has been introduced is the translation of a Greek word by the same English which has been selected as its equivalent, however frequently it may occur; and while tautology is carefully avoided by English speakers and writers, it has been adopted on principle by the Revisers, who have laid down as a self-imposed rule that the variety of words used in the Authorised Version shall be changed into a uniformity which is displeasing to the English ear, and is not necessary as a matter of faithfulness.

The translation of the definite article, wherever it occurs in the Greek, has added force, and brought out the meaning more fully in several cases, but in a very large number of instances it has been as unnecessary and as great a departure from English idiom as it would be to translate the article wherever it occurs in a French or Italian passage.

A few examples will suffice as illustrations of unpleasing English, and they may be taken almost at random, for it is a matter of indifference where the Revised Testament is opened for this purpose.

2 Peter i. 7. has been altered from "And to brotherly kindness add charity," into "And in your love of the brethren supply love."

John xvii. 24, "Father, I will that they whom thou hast given me may be with me where I am," has been changed into "Father, *that* which thou hast given me, I will that where I am, *they* may be with me."

The reason assigned for the change is that *some* MSS. have the neuter ὅ, "that," while the Revisers themselves acknowledge that "*many ancient* authorities have ὅυς," "those whom," which is the old reading and the one that maintains consistency in number throughout the sentence, instead of beginning the sentence with "that" (singular), and ending it with "they" (plural).

Again, "O Jerusalem! (a vocative requiring the second person) which kill*eth* the prophets, and ston*eth* (both third person) them which are sent unto *her* (third person), how often would I have gathered *thy* (second person) children," &c.

Again, "*There* shall be one fold and one shepherd," is changed into "*They* shall be one *flock*" (which is possible); "*one shepherd*," which *they*, clearly, cannot be.

Matthew is said to have been "sitting at the place of *toll*," an English word always implying a turnpike or toll-gate, *e.g.*, for crossing a bridge or admission to some place to be paid for; while the Authorised Version, "sitting at the receipt of custom," is known to mean "sitting to receive taxes," and requires no explanation.

"Enter in at the strait gate" is changed to "Enter *ye* in by the *narrow* gate;" and again, "Many there be that go in thereat," is changed to "Many be they that enter in thereby." The halting and unpleasing character of this last change, "Many be they that enter in thereby," requires no comment, but it is difficult to see that the first of the two changes was called for either by "faithfulness or necessity;" for "strait," as expressing "narrowness," "constraint," or "difficulty," is a word in daily use; and the Revisers themselves have retained the word "straitened," in many instances, to express this meaning.

The Greek word τεκνον means actual "offspring," and therefore "child," or "children," is its strict, first, and most common sense. But child or son, pupil or disciple, may be used in a metaphorical as well as in a literal sense, and in the Authorised Version this variety is fully recognised. But the Revised Version has thought right to change the well-known title of affection, "son," or "my son," as applied to a youth in whom one is interested, to "child," in the case of Timothy and Titus, with the most injurious effect upon both sound and sense. St. Paul is now made to write to the Corinthians, "I have sent Timothy, my beloved child;" and he addresses his letter to him thus:—"To Timothy, my beloved child." He writes to Titus also, "To Titus, my true child, after a common faith;" and again, writing to Philemon about his slave Onesimus, who could not have been a youth at that time, he entreats him "for my child Onesimus."

Another unnecessary change is made in the Revised Version in many instances in which "bread," used as a general term, is changed into "loaf," or "loaf" is put in the margin, as if it was of importance, because "αρτος" means, literally, "a loaf."

Our Lord, therefore, in the Sermon on the Mount, is now made to say, "If a son shall ask *a loaf*" of one of you that is a father. At his last supper, he is said to have taken bread, "or a loaf;" and, in his appearance to the disciples, after his resurrection, we are told "they saw a fire of coals, and fish laid thereon and bread ('or a loaf'); and Jesus taketh the bread ('or loaf'), and giveth them."

"Our daily *bread*," in the Lord's Prayer, is not changed into "loaf," nor is "loaf" put in the margin, although the Greek—*αρτος*—is the same word as in the foregoing places; nor is "loaf" substituted for "bread" in John vi., "I am the bread of life," &c., although *αρτος* (*artos*) is still the Greek word in every case; nor is any reason assigned for the departure from the rule of uniformity of translation, which is the only apparent reason for the change in the other places.

In the Epistle to the Corinthians, St. Paul uses the same word—*αρτος*—(*artos*), which is still translated as of old, "the *bread* which we break;" but "loaf" is put in the margin. In this case the marginal note is valuable, as a literal "loaf" (a small one) is used in the Greek Church to symbolise the unity of Christians, in accordance with the further expression, "Seeing that *we* who are *many* are *one* (loaf or) bread."

The change of expression from "Lord, is it I?" to "Is it I, Lord?" is universally condemned, and the change of Judas's question, "Master, is it I?" into "Is it I, Rabbi?" is not less unpleasing and unnecessary, and is at variance with English custom, as will be evident to any one who recalls the "My Lord," in a court of justice; "Your Worship," to a magistrate; or the "Please, Sir," of a child making a request to its schoolmaster.

It would be impossible, however, to bring before you any approach to the alterations made in the Revised Version, for they number altogether about 36,000, of which nearly 30,000 are unnecessary, according to the estimate of the Bishop of Gloucester himself. *

IMPROVED TRANSLATIONS SUGGESTED TO THE SOCIETY IN PREVIOUS SESSIONS.

In previous Sessions various suggestions for improved renderings of the Authorised Version have been brought before this Society, and many of the proposed changes are to be found in the Revised Version. In nearly every case the change from "damnation" into "judgment" or "condemnation" is made in the Revised Version, but it is much to be regretted that "hell fire" should have been changed (as it has been) into "the hell of fire;" for in this translation every objection that has ever been urged against the rendering of "Gehenna" by the word "Hell," remains unaffected, while the additional evil has been imported into the translation that the words appear to sanction the pagan notion of a variety of hells—a hell of fire, and a hell of frost, a hell of thirst, like that of Tantalus, or of unceasing unavailing toil, like that of Sisyphus. The change proposed to you in the translation of "hypocrite" has found no sanction in the Revised Version, nor has the proposal been approved by the Revisers to change the translation of συνίημι, in the parable of the Sower, from "understand" the word preached, to "attend to" it; but the important change proposed in the Epistle to the Galatians has been made from "the spirit lusteth against the flesh, and the flesh lusteth against the spirit, so that ye *cannot* do the things that ye would," into "so that ye *may* not do the things that ye would." On the other hand, the change of "tempt" into "prove," "test," or "try," in various cases in which no evil object is implied in the narrative, such as "a lawyer asked him a question, tempting him," in Matthew xxii. 35, Mark xii. 28, has not approved itself to the English Company of Revisers, though the American Company record their desire in the "Appendix" that the change should have been made.

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* See the book on the "proposed" Revision, published by the Bishop of Gloucester in 1870. He was Chairman of the Revision Committee, and in this book he goes into elaborate calculations, illustrated by several chapters of proposed changes, and he concludes that one change per verse (6,944 verses) will be the maximum of changes of translation either necessary or desirable; and he suggests that some even of these may be considered doubtful improvements, and may be rejected. (p. 128.)

EMPLOYMENT OF "WHICH" AS A MASCULINE OR FEMININE.

There is another point, of purely literary interest, upon which the American and English Revisionists also differ, viz.:—the employment of the word "which," when it is applied to persons, as in the case of the Lord's Prayer, "Our Father, *which* art in Heaven." The "which" has been generally, but not always, retained by the English Revisionists, while the American Company record their desire that "who" should have been substituted when the relative refers to a person, whether male or female.

Upon this point it may not be without interest to see how far "which" is really a neuter pronoun in the English language; and the answer is clearly that in the Tudor period it was both masculine, feminine, and neuter, like "that" in the present day; and its employment in any particular case was largely, if not almost entirely, determined by the first letter of the word immediately following it. It may be stated in general terms that "which" was used in preference to "who" whenever the following word commenced with the letter "w," with "wh," with a vowel, or with an aspirate, or when the word immediately going before was strongly aspirated; but that if the succeeding word began with a consonant, "who" was commonly employed in the masculine and feminine genders.

It is remarkable to notice how seldom Chaucer, in the later Plantagenet period, employs either relative; for he adopts the practice which is common in modern English of using the pronoun "that" in such cases as those above-mentioned, though he sometimes employs both "which" and "who" as masculines, and apparently without reference to the consideration above pointed out.

Shakespeare very seldom employs either "who" or "which," but makes use of "that." So far, however, as my reading goes, he acts upon the principle alluded to when he does use them.

Thus, in Hamlet, Act iv., Scene vi. (the last line), he says:—

> " . . . that you may direct me
> To him from *whom* you brought them."

"Whom" is made use of before the consonant "y," but in the immediately following lines he says—Act iv., Scene vii., lines 4 and 5:—

> " That he, *which hath* your noble father slain,
> Pursu'd my life."

"Which," after the masculine, is here adopted before the aspirate "hath," and the difference in sound between the succession of aspirates "he, who, hath," and "he which hath," only requires to be mentioned to be appreciated.

In Spencer, we meet with the employment of "which" not unfrequently, and he seldom departs from the rule that I have suggested. Thus, in the "Legend of Artegall," he is speaking of Queen Elizabeth sitting in majesty in her High Court of Justice, and he says—Canto ix., verse 23, lines 5 and 6:—

> " . . . as if that there were some
> *Which unto* them was dealing righteous doom."

"Which," referring to a feminine (the Queen), is here employed before the vowel "u"; but "who" is employed before a consonant in verse 27, line 3, where we find:—

> "Unto the presence of that gracious Queen
> *Who s*ate on high."

In verse 40, line 3, he returns, however, to "which" as applied to a female (Duessa), before an aspirate:—

> "The false Duessa *which h*ad wrought great care."

In accordance with this principle, "which" is employed before the vowel "a" in "Our father *which a*rt," and it is used before the vowel "i" in Matthew v. 16, "Glorify your Father *which i*s in heaven." "Which" is also used before "w" in Matthew xviii. 23, "A certain King, *which w*ould take account" &c.; and also in Acts, Felix and his wife "Drusilla, *which w*as a Jewess." It is employed before an aspirate in Matthew ix. 8, "And glorified God, *which h*ad given such power," &c., while "who" is used before a consonant in John i. 27, "He it is, *who c*oming after me," &c. There are, however, numerous exceptions to this principle, but they are exceptions.

The principle above illustrated is still in daily operation in our own language, in which "a" becomes "an" before a vowel or a silent "h"; and it is in constant employment in continental languages, such as the French and Italian, in which a consonant is interposed between two words, if one ends and the next begins with a vowel; and every Welsh scholar is familiar with the manner in which b, f, and v are changed one into the other, according to the first letter of the succeeding word.

THE GREEK TEXT.

We come now, however, to a much more serious consideration than any mere question of elegance in the English employed by the Revisionists, or alleged archaisms retained by them; for the question has lately been raised, and demands the most anxious attention, whether the Revisionists have not really given us a translation of a New Testament of their own framing, instead of merely an improved version of the old one, which they were appointed simply to revise where it was absolutely necessary. A recent article in the *Quarterly Review* (October, 1881) has made a serious assault upon the Greek text itself put forward by the Revisers; and unless it receives a reply which is more intelligible and convincing than any yet before the public, the character of the new text, and its claim to be received as simply a more trustworthy form of the old one, will be seriously doubted. The "Notes on Select Readings," in Westcott & Hort's "Introduction," furnish a reply in a *limited* number of instances; and other works, such as those by Alford, Tischendorf, etc., may supply an answer in other cases convincing to scholars trained in such studies as textual criticism; but even to a person of more than average classical education, they are often barely intelligible, from their peculiar form and the special training necessary for understanding them; and to an ordinary reader they are perfectly unintelligible and unconvincing. When such a person finds a marginal note, "many ancient authorities," or "some ancient authorities," "omit," or "insert," a passage in the New Testament which he has been accustomed, and justly so, to regard as of high importance, none of the works alluded to would enable him to learn what is the weight of this indefinite number of "many" or "some" "ancient" authorities, and a doubt is cast in his mind which there are no means of his solving. If the altered text had been addressed only to scholars, they might have been able to judge of its value, but the 6,000 textual alterations are put before the general reader with doubts appended to many of them, and no means whatever of answering the doubt.

A weighty reply has been made by the Rev. W. Sanday to some of the criticisms (*Contemp. Rev.*, Dec., 1881), and it is impossible for any one with less attainments than the authors of both these articles to express an opinion as to whether the others may or may not admit of a full reply; but they call for one if the revised text is to hold a secure position in general estimation in the future.*

The general character of the charges against the revised text is, that the Revisionists have accepted errors from the more newly-discovered MSS., and have either incorporated them with the text, or given countenance to them by marginal notes; that they have made numerous and important omissions without any note to warn the reader; and that they have frequently thrown doubt upon the authority of what they have still retained in the text, by marginal notes implying doubt, without any sufficient reason assigned for doing so.

In order to appreciate the grounds upon which the attacks and the defence of the new text are based, it will not be out of place to inquire into the character and authority of what is called the "Textus Receptus," from which the *Authorised Version* of the New Testament was made, and to examine the materials for judging of its accuracy and value.

ORIGIN OF THE "TEXTUS RECEPTUS."

The first *published* edition of the Greek Testament was edited by Erasmus, in Basle, in 1516, from *five* MSS. now in the public library of Basle, and a *sixth* in the library of the Prince of Oettingen-Wallerstein, not one of which was ancient or contained the whole of the New Testament, though, from the six together, Erasmus did obtain the whole, except the last six verses of the Apocalypse, which he supplied from the Vulgate.

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* Since this paper has been in the printers' hands, a still more valuable reply has been made in a pamphlet, entitled "The Revisers and the Greek Text of the New Testament." The moderation and gravity of its tone contrast favourably with some of the defences put forward, and the authors (two annonymous members of the New Testament Company) may advantageously amplify their reply, and extend it to many cases which they have not touched upon.

In 1550, the learned printer, Robert Stephen, published a new edition in Paris, for which he used the Complutensian Polyglot, and also *fifteen* MSS., of which two were ancient, one being now known as Beza's Codex, attributed to the fifth or sixth century, the other being of the eighth or ninth century, while the remainder were comparatively modern. After the death of Stephen, Beza brought out some fresh editions, but chiefly from the materials already contained in those of Erasmus and Stephen, and the Complutensian Bible; and in 1633 the celebrated printer, Elzevir, of Leyden, brought out an edition, based upon the foregoing, in which he informed the reader that he had before him "the text now received by all," from which circumstance the name "Textus Receptus" arose.

The translators of the Bible in King James's reign, in 1611, do not specify carefully the sources from which they obtained their text, which is chiefly that of Beza, with occasional preference for Stephen's; but in some few instances their text differs from both without the sources being mentioned from which the differences were taken. The so-called Textus Receptus, from which the Authórised Version was made, appears, therefore, to have been obtained from a very limited number of manuscripts, very few of these being known to be ancient. Under these circumstances it is a wonderful proof of the almost incredible care that must have been exercised in making MS. copies of the Scriptures, that after all the ingenuity of captious critics for the purpose of finding faults, and all the care and research of reverend ones for the purpose of eliminating errors or supplying omissions, scarcely a single change of vital importance has had to be made, as the result either of their hostile or friendly criticism.

It is, however, a matter of interest to learn that the MSS. used by Erasmus, although not themselves ancient, correspond so closely with the general mass of Cursives, which are generally about the ninth and tenth century, as to carry the actual date of his authorities to that remote period. And here again it is to be noted that these Cursives correspond in all substantial particulars with the readings followed by Chrysostom; which takes the date further back to his time—the end of the fourth century. The conclusion, therefore, at which criticism appears to have arrived is, that Erasmus's text was substantially that which was prevalent in Antioch and Constantinople in the end of the fourth century.*

DESCRIPTION OF THE PRINCIPAL UNCIAL CODICES.

Since the date of the Authorised Version, a very large addition has been made to the number and weight of MS. copies of the whole or of portions of the New Testament, the most important of which may be here enumerated. When they are Greek, they are generally described by a capital letter, A, B, &c., or by an Arabic numeral, 1, 2, 3, &c., or by small Italics when they are in other languages, and they are spoken of as "Uncials," or "Cursives," according as they are written in large capital letters (*uncia*, an inch,) or in smaller running hand (*curro*, to run). They are also generally called "Codex A," † &c., instead of "MS. A," &c.,

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* Condensed from Westcott & Hort, "Introduction," § 130, pp. 91, 92, and "Revisers and the Greek Text," pp. 11–14.

† Codex means originally, in Latin, the trunk of a tree, and thence a thin piece of wood which, being covered with wax, was used for writing upon with a "style." It thus became the term for a single sheet of manu-

when in capital or "uncial" letters, while an MS. in smaller running hand is described as "Cursive 1, 17," &c.

There are above one hundred and fifty known uncial copies of more or less of the New Testament, but the following are the most important in the controversy upon the Revised Version:—

A. The Codex Alexandrinus was obtained from Alexandria, and is attributed to the fourth or fifth century. It contains the Old Testament, and the whole of the New Testament, with the exception of the first twenty-five chapters of St. Matthew and two chapters of St. John's Gospel, and eight chapters in the 2nd Epistle to the Corinthians. It corresponds much more nearly with the Textus Receptus than any other of the great uncials.

It was not available for the Authorised Version, having only been presented by the Patriarch of Constantinople to Charles the First in 1628. It is deposited in the British Museum.

Its character is thus described by Dr. Scrivener,* a member of the Revision Committee:—"This celebrated MS. . . . yielding in value to but one or two at the utmost." (p. 90.) . . . "A has been judged to be carelessly written. Many errors of transcription no doubt exist, but not more than in other copies of the highest value (*e.g.* Codex ℵ, and possibly even Codex B." (p. 95.) "This MS. is of the very

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script, and often a term for a number of sheets or a volume of MSS. The term was afterwards extended to a collection of various matters, such as a volume of Laws, like the Justinian Code, or the Code Napoleon, or the French "Codex," which is the authorised edition of receipts for preparing medicines. In speaking of ancient writings, however, the term is simply used to mean a "manuscript," whether of a single sheet only, or of the entire Bible. Thus "Codex A" is an MS. of the whole Bible; "Codex Z" is only a fragment of St. Matt. Gospel. The term "Codex" was so little in use, even in the beginning of the present century, that it is not to be found in Todd's Edition of Johnson's Dictionary, 5 vols., 4to. ed., 1818.

* *Introduction to the Criticism of the New Testament*, 2nd ed., p. 90–95.

greatest importance to the critic, inasmuch as it exhibits (especially in the Gospels) a text more nearly approaching that found in the later copies than is read in others of high antiquity." (p. 95.)

B. The VATICAN CODEX is attributed to the fourth century, but its actual history is unknown previous to 1457, when it first appeared in the published catalogue of the Vatican Library in Rome. It was, however, kept from the public so jealously, that it was not really available until 1848, when a facsimile edition of it was published.* It contains nearly the whole of the Old Testament, and the New Testament, with the exception of St. Paul's Epistles to Timothy, Titus and Philemon, and the Apocalypse. *This Codex is of supreme importance in the controversy relating to the Revised Version, as most of the changes in the Greek text appear to be dependent chiefly upon its authority.* Professors Westcott and Hort, in the Introduction to their New Greek Testament, assign to it decidedly the first place among ancient authorities, and the *Quarterly Reviewer* (October, 1881) speaks of it as having acquired an influence during the last twenty years which amounts almost to a superstition. Dr. Scrivener thus describes its CHARACTER †:—"Those who agree the most unreservedly respecting the age of the Codex Vaticanus, vary widely in their estimate of its critical value. By some it has been held in such undue esteem, that its readings, if probable in themselves, and supported (or even though unsupported) by two or three other copies or versions, have been accepted in preference to the united testimony of all authorities beside; while others have spoken of its text as one of the most vicious extant. . . We may say at once that neither of these views can commend itself to impartial judges; that while we accord to Codex B at least as much weight as to any single document in existence, we ought never to forget that it is but one out of many, some of them being nearly (and one quite) as old, and in other respects hardly less worthy of confidence than itself. * *One marked feature characteristic of this copy is the great number of its omissions,* which has induced Dr. Dobbin to speak of it as presenting '*an abbreviated text of the New Testament,*' and certainly the facts he states on this point are startling enough. He calculates that Codex B leaves out words or whole clauses not less than 330 times in Matthew; 365 in Mark; 439 in Luke; 357 in John; 384 in Acts; and 681 in the succeeding Epistles; or 2,556 in all. That no small proportion of these are mere oversights of the scribe seems evident, . . . but by no means enhances our estimate of the care employed in copying this venerable record of primitive Christianity." (p. 108.)

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* Of which a copy is in the Liverpool Free Library. † "Introduction."

C. Codex Ephraemi, is a *Palimpsest,* a term applied to works the original MS. of which has been erased or written over by some other MS. It is attributed to the fifth century, and contained originally both the Old and New Testaments, a great portion of which, in fragments, still remains legible, or has lately been rendered so by the application of a chemical substance, which has revived the old MS. It is in the National Library in Paris, and has been available since about 1834. Dr. Scrivener thus describes its CHARACTER †:—"It is carefully transcribed, and of its great critical value there is no doubt. Its text seems to stand nearly midway between A and B, somewhat inclining to the latter." (p. 111.)

D. The Codex Bezæ is of more doubtful date than the others, but it is referred to the fifth or sixth century. It is in the University Library, Cambridge. It consists of the Gospels, but it is much mutilated, and is characterised by containing many portions not found in other authorities. Dr. Roberts, one of the Revisionists, says (p. 23):—"Many strange interpolations and manifest corruptions occur in it, but it is nevertheless of great value"; and Drs. Westcott and Hort (*New Testament, in the Original Greek*, Introduction, p. 149), say:—"In spite of the *prodigious amount of error* which D contains" . . . "To what extent its unique readings are due to licence on the part of the scribe, rather than to faithful reproduction of an antecedent text, now otherwise lost, it is impossible to say; but it is remarkable how frequently the discovery of fresh evidence, especially Old Latin, supplies a second authority for readings in which D has hitherto stood alone." Dr. Scrivener thus speaks of it*:—"The internal character of the Codex Bezæ is a most difficult, and indeed an almost inexhaustible, theme. No known MS. contains so many bold and extensive interpolations (600, it is said, in the Acts alone). . . For the present we shall simply say, with Davidson, that 'its singularly corrupt type, in connection with its great antiquity, is a curious problem which cannot be easily solved." (p. 118.)

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* The portions in Italics are emphasised by the Author of this paper, not by Dr. Scrivener.

† "Introduction."

D2. Codex Claromontanus, in the National Library at Paris, contains the Epistles, and is the second portion of the Codex Bezæ, which contains only the Gospels and Acts.

ℵ. (*Aleph*) Codex Sinaiticus was discovered by Dr. Tischendorf in the convent of St. Catherine, on Mount Sinai, in 1859, and is now in the Imperial Library in St. Petersburg. Dr. Roberts (p. 24) speaks of it as follows:—"Tischendorf was naturally disposed to exaggerate somewhat both the antiquity and value of his wonderful discovery. He also adopted some impossible readings on the sole authority of this Codex, and in general allowed it undue weight in the establishment of the text of the New Testament. Although it contains many obvious errors, it yields assistance of a kind most precious towards the settlement of the true text of the New Testament." Dr. Scrivener,* speaking of its date, says that "it is a veritable relic of the middle of the fourth century" (p. 86), and, as to its CHARACTER and WEIGHT, he says, "It so lends its great authority, now to one and now to another (reading), as to convince us more than ever of the futility of seeking to derive the genuine text of the New Testament from any one copy, however ancient and on the whole trustworthy." (p. 89.)

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* "Introduction."

Of the remaining uncials (nearly 150), Dr. Scrivener † says briefly:—"Codices ℵ, A, B, C, for their critical value; Codex D, for its numberless and strange deviations from other authorities; and all five for their high antiquity, demanded a full description. Of those which follow (containing fragments only), none need detain us long." (p. 118.) The following table contains a brief account of them, which may be useful for reference in such cases as page 290.

The five great codices have been described so fully, because the controversy respecting the changes in the Greek text turns almost entirely upon their respective value. The Textus Receptus, from which the Authorised Version was made, corresponds most nearly with A, while the changes in the Greek text made by the Revisionists are generally due to the influence of ℵ and B, either separately or conjointly, and they are generally also in the direction of omitting portions contained in the Authorised Version, omissions being the characteristic of B. These two great uncials resemble each other so closely, and in so many important particulars, as to point strongly to some more ancient common original; and while this common original is acknowledged on both sides, it

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* "Introduction." † Ibid.

MINOR CODICES, COMPILED FROM DR. SCRIVENER'S "INTRODUCTION TO THE CRITICISM OF THE NEW TESTAMENT."

Title.	Contents.	Supposed Date.	At Present in.	Characteristics and References.
E Codex Basiliensis E_2	Nearly all the 4 Gospels, Acts (W. & H., p. 15)	Mid. 8th cent.	Basle	Very good, p. 103.
F ,, Borelli	4 Gospels, defective	9th or 10th cent.	Pub. Lib., Utrecht	Very defective, 104.
F ,, Augiensis	St. Paul's Epistles	7th cent. (?)	Trin. Coll., Cambridge	See below, 135.*
F^a ,, Coislin I	Frag. Gosp., Acts, & Epis.	6th or 7th cent.	Coislin Lib.	No comments, 105.
G_3 ,, Boernerianus	St. Paul's Epistles	8th cent. (?)	Imp. Lib., Dresden	Strongly resembles F, 135.
G ,, Wolfii A (Harleian)	Frag. of Gospels	10th cent.	British Museum	106
H ,, Wolfii B	Ditto	9th cent.	Pub. Lib., Hamburgh	Higher value than G, 106.
H ,, Coislin, 202	14 leaves St. Paul's Epis.	6th cent.	Imp. Lib., Paris	"Very precious fragments," 137.
I ,, Tischendorf II	Frag. of 7 different MSS. of Gospels, Acts, and Epis.	5th and 6th cent.	St. Petersburg	Palimpsests. First 5 rank high, 107.
K ,, Cyprius	4 Gospels, complete	Mid. 9th cent.	Imp. Lib., Paris	Unusual and interesting, 108.
L ,, Regius	4 Gospels, almost complete	8th cent.	Ditto	"Most remarkable document of its age or class," 108.
M ,, Campianus	4 Gospels, complete	End of 9th cent.	Ditto	Very good, 110.
M ,, Ruber (in red ink)	St. Paul's Epistles	Perhaps 10th cent.	Pub. Lib., Hamburgh	Excellence and critical value of the text, 138.
M ,, Purpureus	Only 12 leaves frag. Gosp. (which are divided among three libraries)	End of 6th cent.	British Museum Vatican Vienna	Beautiful copy, 110.
N^e Fragmenta Mosquensia	Frag. St. Paul's Epistles	Probably 6th cent.	Holy Synod, Moscow	
N^d Codex Musei Brittannici	Frag. of St. John's Gospel	4th or 5th cent	British Museum	Palimpsests—very difficult to read, 111.
O	7 small frag. Matthew, Luke, John	10th cent.	Wolfenbüttel	112.
O^e	Magnificat, Benedictus,	6th, 7th, 8th, and	Bodleian, Oxford	112.

P Codex Guelpherbytanus A	Frag. of 4 Gospels	6th cent.	Ducal Lib.	Palimpsests—very difficult to read, 112.
Q " " B	Frag. Luke and John .	5th cent.	Wolfenbüttel	
R (letter assigned to different books by various editors)	Palimpsest frag. of Gospels	6th to 9th cent.	Various places	Difficult to read, 114.
S Codex Vaticanus, 354	4 Gospels, complete	A.D. 949	Vatican	Earliest dated MS., 115.
T " Bazianus	Frag. Luke and John	4th or 5th cent.	Propaganda, Rome	
T^a	Ditto			Copyist has made many blunders, 116.
U " Nanianus I	4 Gospels, entire	10th cent.	St. Mark, Venice	"Carefully and luxuriously written," 107.
V " Mosquensis	Frag. 4 Gospels	8th or 9th cent.	Holy Synod, Moscow	117.
W^a " Reg. Paris	2 leaves only, Luke	8th cent.	Paris	117.
W^c II	3 leaves, Mark, Luke	8th cent.	Lib. St. Gall	Palimpsest, 118.
X Codex Monacensis	4 Gospels, with serious defects	9th or early 10th cent.	Univ. Lib., Munich	Valuable MS., 118.
Y " Barberini	6 leaves of John	8th cent.	Rome	119.
Z " Dublensis Rescriptus	Frag. Matthew	6th cent.	Trin. Coll., Dublin	One of the chief Palimpsests extant, 119.
B " Vatican, 2066	The whole Apocalypse			140.
Γ " Tischendorf IV	Luke and frag. other Gosp.	9th cent, probably A.D. 844	Bodleian	Deserve careful study, 121.
" Another portion	Missing portions of Gosp.		St. Petersburg	121.
Δ " Sangallensis	4 Gospels nearly complete	Probably 9th cent.	St. Gall, Swiss	Of little critical value, 122.
Θ " Tischendorf I	4 leaves of Matthew	End 7th cent.	Univ. Lib., Leipsic	"Almost too brittle to be touched," 124.
Λ (1) "	2 torn frag. Matthew and Luke	9th cent.		Only 14 verses in all, 124.
" Tischendorf III	Gospels Luke and John, complete		Bodleian	Text varies greatly from later uncials, 125.
Ξ " Zacynthius	Much of Luke	8th cent.	Brit. & For. Bible Soc., London	Earliest known copy furnished with a Catena. Its readings are very valuable, 126.

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* F "abounds as much as any with real variations from the common text, and with numberless error s of the pen," 135.

is denounced by the *Quarterly Reviewer* as being exceptionally corrupt, while it is upheld by Drs. Westcott and Hort as having been of exceptional purity, and the nearest possible approach to the words themselves of the sacred writers. Upon this difference of opinion it is not unimportant to remember that Dr. Scrivener says (Introd., p. 386, 1st ed.), "The worst corruptions to which the New Testament has ever been subjected originated within a hundred years after it was composed," *i.e.*, before the actual words of the originals had acquired the sacred character in the estimation of Christians which they gradually attained, as the New Testament writings grew to be looked upon as αἱ γραφαι—sacred writings—like "the other Scriptures." These corruptions, whether of omission or of addition, were gradually corrected with scrupulous care, especially in the fourth century, and in many instances the "versions," and the quotations by Christian writers of this and even a later period, were more trustworthy than the less scrupulously correct text of an earlier date.

THE IMPORTANT QUESTION TO BE SETTLED.

There seems to be little reason to doubt the antiquity of the two great uncials ℵ and B; but the consideration of their age is very different from that of the faithfulness with which they represent the words of the Evangelists and Apostles, and the real question at issue appears to be: Are these two recently-discovered MSS.—ℵ and B,—though of unknown authorship, and dating from a period of great corruption of the text, differing from each other in important particulars, and differing still more widely from all others, to be accepted as almost unquestionable authorities, over the heads of all other MSS., and of versions made from MSS. also, some of the versions being of greater antiquity than ℵ and B; and the MSS. of others being of an age in which the greatest care had been taken to ensure scrupulous accuracy in the sacred text. Messrs. Westcott and Hort, supported by the Revisionists as a body, appear to make this claim; and it has been acted upon in the alterations made in the new text. Objectors to the claim are neither few nor unlearned; and the question is one which will have to be settled before the Revised Version can be accepted with the feeling of confidence that has hitherto attached to the Authorised Version of the New Testament.

Some idea may be formed of the number of changes likely to be made in the Greek text of the New Testament, if the authority of these various uncials is accepted, from the following table, compiled from the *Quarterly Review* article:—

SERIOUS differences in the GOSPELS alone between the Textus Receptus and

A	842 differences.
C	1798, or twice that number.
B	2878, above three times ,,
ℵ	3392, above four times ,,
D	4697, nearly six times ,,

AMOUNT OF MS. EVIDENCE FOR THE NEW TESTAMENT AND VARIOUS CLASSICAL WORKS.

The amount of MS. evidence to be taken into account in determining the Greek text of the New Testament is startling, when it is compared with what is possessed in the case of the most eminent classic authors. High authorities * speak of known MSS. of the whole or parts only of Herodotus as 14; Plato, 10, "but probably more"; Xenophon's Anabasis, 5; Virgil, 7, as old as the third and fifth centuries; Horace, at least 16, "but probably more numerous"; Ovid, at least 20; Tacitus, about 18.

* Supplied to the author by the Rev. Canon Butler.

But of almost the *entire* New Testament, there are the five great uncials; and of portions, more or less extensive, there are:—

Uncials examined and catalogued, 158 (Newth).

Cursives of the *whole* New Testament, about 30 (Westcott and Hort, "Introduction," p. 76).

MSS. (uncial or cursive) of the Gospels, there are 685; of the Acts and Catholic Epistles, 242; of the Pauline Epistles, 298; of the Apocalypse, 110.

Lectionaries, or special portions appointed to be publicly read in the Greek churches, there are 428, of which 347 contain passages from the Gospels, and 81 from the Acts and Epistles, making nearly 1,800 MSS. which have been catalogued and more or less carefully examined. (Newth, p. 80.)

When to this list is added the quotations by the early Christian writers, and the versions made in the first few centuries into almost every Eastern language, as well as into Latin and Gothic, the amount of evidence to be considered is overwhelming, and appears utterly beyond the power of any mixed company to decide upon, when submitted to it for immediate adoption or rejection.

METHOD ADOPTED IN REVISING THE GREEK TEXT.

In order that the principles upon which the *Quarterly Reviewer's* and similar attacks are based may be appreciated by those members of the Society who may not have studied the subject carefully, a few illustrations may indicate their nature, and the degree of weight they appear entitled to claim; and in this case we have, fortunately, evidence in the two books by Drs. Newth and Roberts (Revisionists themselves), and in the Preface to the Revised Greek Testament, that will prove of value in enabling us to estimate the charges more justly.

The rule laid down for the Revisers by Convocation was very simple and definite. *They were to put their alterations of the text into the margin.* The Revisers, however, supply the information in their Preface, that they found this inconvenient, and therefore they have disregarded it; for they have made nearly 6,000 alterations in the Greek text, or not less than three changes in every four verses. They therefore put the changes which they made day by day into the text, and then at once proceeded to translate them, and issued the translations of the new text as if they had merely revised the old one. The book is therefore *a* version of *a* New Testament; but as it differs in about 6,000 places from the old Greek text, and in about 36,000 places from the former *English translation,* it seems almost a delusion to call it simply a revision, as if it was still the old text with merely such corrections of the translation as were *necessary* for truth.

When we read the Revisers' own account of the manner in which they arrived at their decisions upon alterations in the text, our distrust becomes still stronger; not, however, distrust of the earnestness and conscientiousness of the Committee,—for of this there cannot be a doubt,—but of the capability of any large and fluctuating Committee for such a task as that of correcting, in an ordinary meeting, the Greek text of such a work as the New Testament. From Dr. Newth's description of the usual proceedings, it would appear that the changes in the text were practically dependent upon the opinions of two of the Revisers—Drs. Scrivener and Hort—and that the remainder did apparently little more than endorse them. He thus describes their ordinary mode of procedure (p. 119):—

"The Bishop of Gloucester and Bristol, as chairman, asks whether any *textual* changes are proposed? By tacit consent, the two members of the Company who, from their previous studies, are most competent to speak with authority, state the evidence for and against—viz., Dr. Scrivener and Dr. Hort. Dr. Scrivener opens the matter, and Dr. Hort follows, adding what he thinks important, or differing, as the case may be. After discussion the vote of the Company is taken, and, '*the text being thus settled,*'* the chairman asks for proposals on the rendering."

In his book *On the Revision of the English Testament*, published in 1870, the Bishop of Gloucester (the chairman of the Revision Committee) asks (p. 50), "What amount of change due to purely textual revision might be expected in our present Authorised Version?" and in the following pages he gives careful calculations, from which he arrives at the conclusion (p. 52) "that we should hardly be far wrong in estimating the amount of changes as not exceeding one for every five verses, or under 1,400 in all, very many of these being of a wholly unimportant character." So far from this being the actual limit, it is said that nearly 6,000—not 1,400—has been the real number of changes made. †

REASONS GIVEN FOR OMITTING THE DOXOLOGY.

As an illustration of what had to be taken into account before being able to arrive at a decision as to any important change which should entitle it to be received as conclusive, we may quote Dr. Roberts's account, and his own concluding summary, of the grounds upon which the Revisers decided to omit the Doxology from our Lord's Prayer. (Roberts, p. 60.)

The Doxology is not found in ℵ, B, and D, but it *is*

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* The italics are by the author of this paper.

† The alterations in the Greek text amounted on an average to twenty-five at each sitting of the Committee, though most of them were so trifling as only to be appreciated by minute—almost microscopic—examination.

found in A and C; *i. e.*, it is *not* found in three of these great uncials, but it *is found* in two of them; omissions being the characteristic of ℵ and B.

It is *not* found in the Memphitic (Lower Egypt), the Old Latin, and the Vulgate Versions, but it *is found* in the greater number of the Ancient Versions, viz., the Peshito Syriac, and Cureton's Syriac (which contains "the kingdom," and "the glory," but not "the power"), in the Sahidic (Upper Egypt), the Ethiopic, the Gothic, the Armenian, the Georgian, and the Slavonic; *i.e.*, it is *not* found in three versions, but it *is found* in seven others of the most ancient versions, and it is partially present in an eighth.

It is *not* noticed by the *earliest* Fathers, by Origen in the third century, or by Cyril of Jerusalem, but *it is quoted* by Isidorus in the same century as Origen, and by Chrysostom and other Greek Fathers and by Ambrose in the fourth century; *i. e.*, it is *not* noticed before the third century, nor then, by two eminent Fathers, but *it is* quoted by three of as early date and of equal fame, and by numerous others whose names are not specified.

So far for the external evidence of Uncials, Versions, and Fathers; but Dr. Roberts further alludes to the *internal* evidence, which, he says, "is *somewhat*" against it, as "an interruption of the text." And his conclusion upon the foregoing evidence is that, "upon the whole, criticism must pronounce *decidedly against* the clause as forming part of the original text; and it is accordingly not admitted into the Revised Version." If this is the *decided* conviction produced by the above evidence upon the minds of the Revisers—and it was upon such evidence that this portion of the text has been expunged—those who have not been present at the meetings of the Committee may not impossibly arrive at a different conclusion, not having been subjected to the influence of such powerful minds as often bear sway, from their eminent qualities, in a large company of persons, all of whom do not profess to be specially skilled in such a question as the criticism and correction of a text involving vast research among MSS. and other materials, and presenting such difficulty in estimating their true value as that of Uncials, Versions, and Ancient Fathers.

ILLUSTRATIONS OF THE ORIGIN OF DIFFERENT READINGS IN DIFFERENT MSS. OF THE NEW TESTAMENT.

In order to illustrate the manner in which different readings have found their way into various MS. copies of the New Testament, and now into the Revised Version, and the difficulty of detecting and correcting them, we may take an example from the Acts, the Gospels, and the Epistles. The first is a matter of little more apparent importance than a simple literary curiosity; the second affects us as an unwelcome change in a familiar and time-honoured Christmas hymn; and the third has doctrinal importance attached to it, upon which, in this Society, we do not enter; and the example is simply used to illustrate the complicated difficulty that surrounds some of the investigations.

1st. THE NUMBER OF ST. PAUL'S COMPANIONS IN SHIPWRECK. In Acts xxvii. 37, we read in the Authorised Version, "And we were in all in the ship two hundred threescore and sixteen souls," and in the Revised Version a marginal note is added, "Some ancient authorities read, '*about threescore and sixteen souls*'"—"about" 76, instead of "in all" 276! How could such a discrepancy arise? Probably in the following manner.

The Greek in the Textus Receptus is—

Ἡμεν	δὲ	ἐν	τῷ	πλοίῳ	ἀι	πασαι	ψυχαι	διακόσιαι	ἑβδομηκοντα	ἑξ.
hemen	*de*	*en*	*to*	*ploio*	*hai*	*pasai*	*psuchai*	*diakosiai*	*hebdomekonta*	*hex*
We were	and	in	the	ship	the	all	souls	200	70	6

Some scribe, in copying this, has made a change in the order of the words, either by accident, or supposing it to be an improvement (which is a common source of variety of readings), and has arranged the words as follows:—

ἁι	πασαι	φυχαι	ἐν	τῷ	πλοίῳ.
hai	*pasai*	*psuchai*	*en*	*to*	*ploio.*
the	all	souls	in	the	ship.

But in writing in uncial, or capital letters, no interval was left between the words, and the numbers were written in Greek letters, instead of words. The verse, therefore, became—

ʽΑΙΠΑΣΑΙΨΥΧΑΙΕΝΤΩΠΛΟΙΩCOS,
haipasaipsuchaientoploio

the last three letters being figures C = 200, O = 70, S = 6. In some subsequent copy, the last Ω has been written twice over, and the C, an old-fashioned form of S (200), has been joined to it, and the verse has thus become—

ʽΑΙ	ΠΑΣΑΙ	ΨΥΧΑΙ	ΕΝ	ΤΩ	ΠΛΟΙΩ	ΩC	O	S
hai	*pasai*	*psuchai*	*en*	*to*	*ploio*	*os*		
the	all	souls	in	the	ship	about	70	6

and the original "276" has thus become "about 76," from the repetition, by accident, of a single letter.

2nd. THE ANGELIC HYMN (Christmas). In the Authorised Version this hymn, in St. Luke ii. 14, is "Glory to God in the highest, and on earth peace, good will towards men," which is altered in the Revised Version into—

"Glory to God in the highest,
And on earth peace among men in whom he is well pleased."

How can such a discrepancy be accounted for? In the Textus Receptus, the Greek is—

Δόξα εν ὑψίστοις Θεῷ, καὶ επὶ γῆς εἰρήνη, εν ἀνθρώποις
Glory in the highest to God and upon earth peace, in (or towards) men
εὐδοκία
good will (or good pleasure).

Assuming this to be the hymn as really sung by the angels, the nominative "peace" before "to men," and the nominative "good will" following it, would seem to have struck some copyist as if the latter nominative was a mistake, and as if it ought to be "peace to men *of* good will," or "*of* peaceful disposition;" and the scribe has corrected the supposed error by adding the letter "s," which has changed the nominative *ευδοκια*—*eudokia*—into the genitive *ευδοκιας*—*eudokias*, and the mistake is accounted for.

On the assumption, on the other hand, that *ἐίρήνη εν ανθρωποις ευδοκιας* (*eirene en anthropois eudokias*) was the real form of the angelic hymn, the scribe who introduced the change must have dropped the final "ς" in *ευδοκιας*—*eudokias*—an omission that might very easily occur by simple accident.

When the evidence in favour of the hymn as we have always been accustomed to it in the Authorised Version, is compared with the altered form in the Revised Version, it will be seen that the change in the Revised Version depends almost entirely upon the great uncials discovered since the Authorised Version was translated; while the evidence from the Ancient Versions and other sources is almost entirely in favour of the old form.

For "Good will towards men." (the nominative.)	For "Peace among men in whom he is well pleased." (the genitive.)
MSS.	
A has the nominative in the "Gloria in Excelsis," or the "Morning Hymn," after the Psalms.	A has the genitive in Luke. ℵ, B, and D have the genitive.
C is defective in this portion (W. & H.), and therefore is put aside.	
The Greek Psalters (W. & H.)	
Every known Lectionary (*Quar. Rev.*)	

VERSIONS.

Syriac—Peshito. " Cureton's—Chap. lost. Egyptian—Memphitic. " Thebaic or Sahidic "defective" (W. & H.) Ethiopic. Armenian. Georgian. } Rev. Dr. Malan. Arabic. } Slavonic. Original Greek.*	All known *Latin* Versions. Gothic.

ANCIENT ECCLESIASTICAL AUTHORITY.

The Ecclesiastical usage of the *Eastern* Church (*Quar. Rev.*) Apostolic Constitutions (W. & H.) 2nd century, Irenæus (*Quar. Rev.*) 3rd " Origen (W. & H.) 4th " Eusebius, and very many others of the highest authority. 5th century. The Eastern Bishops assembled together at Ephesus. (*Quar. Rev*) And several other Fathers in the 6th, 7th, and 8th centuries, spread over all the East. (*Quar. Rev.*)	*Latin* Liturgies (W. & H.) Irenæus (W. & H.) (As Irenæus is claimed on both sides, it would appear that he sometimes used the hymn one way and sometimes the other.)

If it should be granted that ευδοκιας has established its claim, in spite of the evidence against it, the translation given to it in the Revised Version still remains a question of doubt. The Vulgate has adopted ευδοκιας, and gives the hymn "*et in terra pax homnibus bonæ voluntatis,*" but the

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* The text thus described is sanctioned by the Holy Synod and the Patriarchs and other authorities in the whole Eastern Church, and is used throughout the Greek Communion.

Roman Catholic authorised translation of this into English differs very widely from that given in the Revised Version, for it is translated in the Rheims Version, which has the official authority of the Romish Church, "on earth peace to men *of good will;*" very different indeed from the Revised Version, which renders *ευδοκιας* by "in whom he is well pleased."

3rd. *God* MANIFEST IN THE FLESH—*He who* WAS MANIFEST, &c.

The third illustration exhibits the difficulties encountered, not only in interpretation, but in reading the original letters, for again the controversy turns upon a single letter. 1 Tim. iii. 16: "Great is the mystery of godliness: *God* was manifest in the flesh." (Authorised Version.) This is changed into "*He who* was manifest," in the Revised Version.

The controversy here turns upon whether the Greek word is Θος-, Θ̅ς̅,- Ο̅ς̅-, or Ος, or Ο, the first three being different modes of writing *Theos*—God—in ancient MS. Greek, the fourth being the Greek for "who," and the last the Greek for "which." The Revised Version has adopted "who," as being the true Greek, on the authority of ℵ, A, and C.

It is not disputed that *θε* is present in ℵ, but "the letters are added above the line by the latest corrector of this MS., who is assigned to century xii." (Westcott and Hort, "Introduction," p. 133. Notes.)

Both the cross strokes are present in A, but "the result of microscopical examination shows that they were not originally present, but they have been added at a later date, and by a different penman." (*Idem*, p. 133.)

The Bishop of Gloucester (Bishop Ellicott) pronounces "*indisputably*, after minute personal inspection," that the lines were not originally present, but Dr. Scrivener * says,

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* "Introduction," p. 453, 1st. ed.

"I have always felt convinced, with Berriman and the earlier collators, that Codex A read Θ̅C̅," *i.e.*, that the lines were present. "The opinion of those who had an opportunity of examining the Codex soon after it was brought to England, and when it must have been far easier to decide the question than at present, in the now worn condition of the leaf containing the passage, appears to be almost unanimous that the reading was Θ̅C̅,"† but Alford says that it is a "matter of certainty" that A has Oς. Dr. Roberts says that "א, and probably C, witness to this reading"—Oς—"who."

B does not contain the Epistles to Timothy at all, and D has O neuter, not Oς; so that the case against *Theos*—Θ̅ς̅—turns upon the above three, א, A, and C, of which א appears, from the above account, to be the only one absolutely free from doubt, while D is against Oς, the rendering adopted in the Revised Version, and has the neuter O, which is adopted in several "versions." The original absence, then, or the subsequent loss, of the transverse lines, changes the Θς—God—into Oς, "who." But the Greek sentence is—

> μέγα ἔστὶ τὸ τῆς εὐσεβειας μυστήριον (neuter)
> great is the of the godliness mystery

And if the masculine Oς, "who," follows the neuter "μυστήριον," it is so ungrammatical that most of the scribes who have adopted the relative pronoun in preference to Θς, have converted the Oς, masculine, into O, neuter, resembling the Vulgate, which translates it, "*Magnum est pietatis sacramentum* QUOD *manifestum est in carne*"—"great is the sacrament of piety *which* was manifest in the flesh." (Rheims.) The Revised Version, therefore, in adopting "*He who*," departs not only from the Textus Receptus, but adopts another text which is at variance with the majority of ancient versions. This last objection is dismissed by Westcott and Hort. "The western O is a manifest correction of Oς." (p. 133.)

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† Roberts, p. 68.

In addition to these great MSS., others of less weight, according to present estimation, are adduced. In favour of Θς—C^c, D_3, ? F, K_2, L, L_2, P_2, and, according to the *Quarterly Review*, "*all* the Cursives except No. 17." All the Eastern Lectionaries also support Θς. (*Quarterly Review.*) And for O,-F, and Cursives 17, 73, and 181.

It is not disputed that the Greek Fathers of the fourth century, embracing the highest names—Gregory of Nyssa, Gregory of Nazianzen, Didymus, Chrysostom, and others—adopt Θς, and that Cyril sometimes used Θς, and sometimes Oς, but there are no Greek Fathers of the second or third century who adopt Θς. Such, then, are the arguments on both sides at present before the public; and it cannot be a matter of surprise that those who have been accustomed to read "*God* manifest in the flesh," should be startled and shocked at finding this changed in the Revised Version into "*He who* was manifest," with no further explanation than a simple marginal note, "the word *God*, in place of *He who*, rests on no sufficient ancient evidence."

OMISSIONS IN THE REVISED VERSION WITHOUT ANY NOTE OF WARNING TO THE READER.

Passing over numerous omissions of minor importance, the following from the Gospels alone are important on various grounds. (The words printed in *Italics* are omitted in the Revised Version.)

Matthew	i. 25.	"*firstborn* son."
,,	v. 44.	"*bless them that curse you, do good to them that hate you.*"
,,	xxv. 31.	"*holy* angels with him."
,,	xxvii. 35.	"*that it might be fulfilled.*"
Luke	ii. 40.	"waxed strong *in spirit.*"

Luke	iv. 2.	"he *afterwards* hungered."
,,	iv. 4.	"*but by every word of God.*
,,	iv. 8.	"*Get thee behind me, Satan.*"
,,	vi. 36.	"Be ye *therefore* merciful, as your Father . . . is merciful."
,,	vii. 28.	"there is not a greater *prophet.*"
,,	ix. 57.	"*Lord,* I will follow thee."
,,	xi. 54.	"*that they might accuse him.*"
,,	xxii. 64.	"*they struck him on the face.*"
,,	xxiii. 42,	"*Lord,* remember me when thou comest."
,,	xxiv. 49.	"tarry ye in the city of *Jerusalem.*"
John	ii. 15.	"*should not perish,* but have eternal life."
,,	iv. 42.	"this is indeed *the Christ,* the Saviour of the world."
,,	v. 16.	"*and sought to slay him.*"
,,	vi. 11.	"*he distributed to the disciples.*"
,,	vi. 47.	"he that believeth *on me.*"
,,	vi. 51.	"the bread . . . is my flesh, *which I will give* for the life of the world."
,,	x. 26.	"*as I said unto you.*"
,,	x. 32.	"from *my* Father."
,,	xiv. 28.	"*my* Father is greater than I."
,,	xvii. 17.	"through *thy* truth."
,,	xviii. 17.	"Art *not* thou also one of them ? "
,,	xix. 7.	"and by *our* law he ought to die."
,,	xix. 16.	"*and led him away.*"
,,	xix. 38.	"took away the body *of Jesus.*"
,,	xx. 17.	"ascended to *my* Father."

Omissions in a Single Gospel (St. Matthew), or Passages still Retained, but accompanied by a Marginal Note implying doubt.

(The omissions or passages of implied doubtfulness are in *Italics*. Only a few instances are given as illustrations.)

Matthew	v. 22.	"angry with his brother *without a cause.*" (Omission.)
„	vi. 13.	Doxology omitted.
„	xi. 15.	"He that hath ears *to hear.*" (Omission.)
„	xii. 47.	"Some ancient authorities omit the verse."
„	xiv. 30.	"But when he saw the wind *boisterous.*" (Omission.)
„	xv. 6.	"honour not his father *or his mother.*" (Omission.)
„	xvi. 2–3.	"Omitted by some of the most ancient and other important authorities."
„	xvi. 13.	"Whom do men say that *I* the Son of man am?" (Omission.)
„	xvii. 21.	Verse omitted. "Many authorities, some ancient, insert" it.
„	xviii. 11.	Verse omitted ("for the Son of man came to save that which was lost"). "Many authorities, some ancient, insert" it.
„	xix. 9.	End of the verse "omitted by some ancient authorities."
„	xix. 29.	"father, or mother, *or wife,* or children." (Omission.) "Many ancient authorities insert 'or wife.'"
„	xxiii. 4.	"heavy burdens, and *grievous to be borne.*" "Many ancient authorities omit."

Matthew xxiii. 14.	Verse omitted. "Some ancient authorities insert" it.
,, xxiv. 36.	"*neither the Son*" is added. "Many authorities, some ancient, omit" it.
,, xxvi. 28.	"this is my blood of the *new* testament." (Omission.) "Many ancient authorities insert" it.

THE LORD'S PRAYER.

Of all the changes made in the text or the translation, none have excited such distrust and condemnation as the omission of the Doxology, and the change of the last petition in the Lord's prayer into "deliver us from the evil *one*," instead of "deliver us from evil;" and to this question we will now turn as the conclusion of this review.

The arguments for and against the change have been put forward at great length, on the one hand, by the Bishop of Durham, who was the principal agent in obtaining the change, and on the other by Canon Cook, the Editor of the *Speaker's Commentary;* and as the learning and ability of these two distinguished scholars are very equally matched, it is generally admitted that the case has now been pleaded by what may be called two of the most eminent living counsel; and their arguments may be summarised as follows:—

The entire controversy turns upon the meaning of the two Greek words, "*του πονηρου*," in the last petition in our Lord's prayer. There is no dispute about the words themselves. The Revised text leaves them unchanged, and the advocates on both sides claim them as favouring their own view. The Rule of Convocation, which was to be binding upon the Revision Committee, was, that nothing was to be changed unless it was *necessary* for the sake of truth and *faithfulness*. On the one hand, then, the Bishop of Durham and the majority of the Revisionists say that the balance of evidence is in favour of "from the evil one," therefore truth and faithfulness make it *necessary* to change the old form into the new one. On the other hand, Canon Cook, the minority of the Revisionists, and others who have taken a part in the discussion, say that there is such conflicting evidence on the matter, and that the evidence in favour of from "evil" simply is so strong, and, as they think, so preponderating, that it was not only not *necessary*, but it was even wrong, to change the words in the text; although it might be right to put in the margin that there was some evidence in favour of "from the evil one," instead of "from evil."

Arguments for and against the Change in the Revised Version of the New Testament of "from evil" into "from the evil one," in the Lord's Prayer.

The Bishop of Durham has published, in the *Guardian*, September, 1881, the arguments which induced the Revision Committee to adopt the change, and the Rev. Canon Cook, the Editor of the *Speaker's Commentary*, has published the objections to the change in a "Letter to the Bishop of London," 3rd edit., 1882, and a second Letter, 1882. Their arguments are summarised below.

It is acknowledged on all hands that the Greek *απο του πονηρου* (*apo tou ponerou*) *may* mean either "evil" generally or "the evil one" (a person, and masculine), but not necessarily the devil.

At one time the preposition *απο* was considered important, as proving that the desired deliverance was from a person, not a thing; but this ground is now given up, as *απο* often occurs before a neuter.

The Bishop of Durham.	Canon Cook.
For "the evil one."	For "evil" generally.
ὁ πονηρος (*ho poneros*) is used by our Lord himself in the para-	The parable of the Sower was some time later than the Lord's

ble of "The Sower," and is expressly explained by him as meaning "the evil one"—the devil.	prayer; and it was in the parable, and not till then, that ὁ πονηρος was specifically used to imply the devil. So far was its meaning in this sense from being self-evident to the disciples, that it had to be explained to them.
The term is used by St. John unmistakably for the devil.	No doubt it is, but this was long after its employment in the Lord's prayer, and after our Lord had stamped a special meaning upon it; and nearer the time of our Lord than St. John's epistles, St. Paul used the term as implying simply a wicked *man*—certainly not the devil—in writing to the Corinthians.
Rabbi Dr. Schiller-Szinessy, of Cambridge, has furnished three quotations from the Misdrash and the Talmud, in which Satan or the devil is designated as "ὁ πονηρος."	These quotations are at least three centuries later than the time of our Lord; and the Jews, at the time of his advent, did not attach any such meaning to the word: and while they had a daily prayer for deliverance from evil of all kinds, they had none for deliverance from the devil.
The SYRIAC version is of very ancient date, almost cotemporary with the last of the Apostles, and was probably written in Aramaic, the same language in which our Lord himself spoke. This version favours "the evil one," for the Greek is translated into "*Bish-o*" (evil—the), which is so constantly used in Syriac for "the devil" (although it *may* mean "evil" generally), that there is no reason to doubt that another	The SYRIAC leaves the question unsettled; for the Bishop acknowledges that "Bisho" *may* be either "evil" or "the evil one," and his own authorities admit the same thing, which is sufficient to show that it was not "necessary," as a matter of "faithfulness," to change the Lord's prayer and to put "the evil one" into the text of the Revised Version, and remove "evil" into the margin.

form of "*Bish*" would have been employed if "evil" generally had been intended. Dr. Neubauer (a great authority) says it may mean "evil" simply, or "*the* evil" emphatically, but *not* "the evil one"; but Dr. Payne Smith, who is a still greater authority, says that "*Bish-o*" means, *imprimis*, "the evil one," and "very seldom" simply "evil."

The EARLY LATIN versions, some of which are very ancient, have "*a malo*," which would mean "from evil" in classical Latin, but not always in these ancient Latin versions, which often use the masculine "*malus*," to mean the devil, as well as a wicked *man*. It is true, however, that one of them uses *Malignus*, with a capital M, when the devil is clearly meant, and others use "*filii nequissimi*," sons of the "most wicked," or "*filii nequam*," or some other distinctive expression when "the evil one" is meant, as distinguished from "evil" generally.

The SAHIDIC version, or that of *Upper* Egypt, is next in antiquity, and it simply adopts the Greek word πονηρος, but makes it into a *masculine* definitely, by prefixing the masculine article. This version clearly renders it "the evil one"

The words "*a malo*" are as indefinite as the Greek itself, and the admissions of the Bishop himself as to the use of Malignus or some other expression, instead of simply *malus*, to imply the devil, are sufficient proof of the uncertainty of the translation of "*a malo*" by "from the evil *one*."

The MEMPHITIC version, or that of *Lower* Egypt, of nearly equal, if not even greater, antiquity, is "altogether ambiguous" on the question, by the acknowledgment of the Bishop of Durham himself, but it is claimed by Canon Cook, on apparently good grounds, as being absolutely neuter, *i. e.*, "evil" in general

	(p. 41 *et seq.*, Second Letter to Bishop of London.)
This is true.	The ETHIOPIC, which is a very ancient version, is unquestionably "evil" in general.
This also is true.	The GOTHIC version, in the 4th century, by Ulphilas, uses the indefinite "*Als thamma ubelin,*" "from *the* evil," which may be either masculine, or neuter.
The Bishop does not controvert this.	Justin Martyr, Irenæus, and Clement of Alexandria (all earlier than Origen), give no support to "the evil one."
Origen, in the third century, unquestionably favours "the evil one," especially in his later writings.	No doubt; but in his later writings he was suspected of unsoundness in the faith, and his time was not until two centuries after Christ, during which interval the philosophy of the Alexandrine schools materially affected the writings even of Christians, and the Greek Church holds him in less esteem as a trustworthy commentator than some others. But his influence was very great, and the subsequent Greek Fathers (and notably St. Chrysostom) adopted his interpretation. But by this time Christianity was in some sort fashionable and the Church corrupt, and Christians might well pray specially for deliverance from the evil *one* in the Church, as well as the world, though our Lord had made the petition general.
Tertullian, a Latin Father before the time of St. Jerome,	This work on prayer was written in his old age, and *after he*

decidedly favours “the evil one,” especially in his work on prayer. This is true about the Latin Fathers.	*had become a Montanist heretic.* It is therefore of little weight in the controversy; and the Latin Fathers generally sanction “evil,” and not “the evil one.”

The LITURGIES are acknowledged to be of little weight in the controversy, as even the ancient ones were altered from time to time, until it is impossible to distinguish what is original from what is of later date.

The arguments on both sides having thus been given from the highest authorities, there are still some that may be thought pertinent to the question; and it appeared to me that it might not be without interest to the Society to show how the various eastern and western churches of every date have understood this petition, and how they have explained it officially to the members of their several communions—to children and others whom it was their duty to teach (though not in a controversial form) what they believed to be the truth; and I propose now to place before you the different versions of the clause in our Lord's prayer, and the interpretations of it, that it has been in my power to obtain. In doing this, I can make no pretence to a knowledge of all the various languages that I shall quote, but I shall mention the authorities who have favoured me with them, and the Society will then judge what weight to attach to them.

INTERPRETATIONS OF THE LORD'S PRAYER, 7TH PETITION. ANCIENT VERSIONS, CATECHISMS, ETC.

The first question is “In what sense would those who heard the prayer when first delivered understand it?”

Contemporary Jews—

> “They would not think for a moment of the devil or Satan when told to pray for deliverance from evil.”

The late Rabbi Prag, whose acquaintance with Rabbinical and Talmudic learning is well known in the Hebrew community, and (through his son) the Chief Rabbi in London, Dr. Adler:

Rev. Dr. Stern, Minister of the Hope Place Synagogue, Liverpool;

And other Jewish Ministers.

Greek Text, New Testament—*απο του πονηρου*—Indefinite. May be masculine or neuter—from "evil," from "the evil thing," or from "the evil person."

The Greek Fathers, previous to the time of Origen (third century), give no decisive interpretation.

From Origen (third century) downwards, they interpreted it as "the evil one."

The Greek Church, "following tradition, and especially the authority of St. Chrysostom, *understands* it as "the evil one, the devil, the source of all evil;" but it *explains* the prayer to children and catechumens as meaning "deliver us from the devil, who is the father of all evil."

Rev. Dr. Stratuli, lately Archimandrite of the Greek Church in Liverpool, now Bishop of Cythera.

"My Rev. Brother, the Archimandrite of Liverpool, seems to have hit the right note when he told you that the phrase, in its literal meaning, refers to 'the evil one,' but in its applied meaning it is made to extend to all his works, which are of necessity 'evil,' and only evil."—Very Rev. Father Hatherley, Archpriest of the Patriarchal Œcumenical Throne of Constantinople, Priest of the Greek Church, Bristol.

Greek Catechism of the Holy Catholic Apostolic and

Orthodox Church (Athens, 1857), approved by the Holy Synod of Greece, and by the Patriarch of Antioch. Translated by J. T. Seccombe, M.D. Ch. iii., s. ii., clause 7. James Wood, Cardiff. Printed by Levey & Co., Great New Street, Fetter Lane.

"In the petition we call upon our heavenly Father to deliver us from all sin, and from every occasion which might lead us into sin."

"ORTHODOX CONFESSION," by Peter Mogila. Lond., 1762. p. 171.

"We hereby pray to God, 1st, to deliver us from all kinds of evil; 2nd, that His grace might accompany us and keep us from falling into His displeasure, . . . more especially we pray that in the hour of death He would protect us from all the insults of the enemy of our souls."

"LONGER CATECHISM of the Orthodox Catholic Eastern Church." Moscow, 1839; Lond., 1845. p. 109.

"We ask for deliverance from all evil that can reach us in the world, which, since the fall, lieth in wickedness; but especially from the evil of sin, and from the evil suggestions and snares of the spirit of evil, which is the devil."

SYRIAC. The "PESHITO," *i.e.*, "perfect," "simple," version, of the New Testament. 2nd century—early. Probably the language or a dialect of the language in which our Lord originally delivered the prayer.

Bish-o. "Evil, the." Indefinite.

"Generally, almost always, masculine."—Bishop of Durham.

y be 'evil' or 'the evil,' not the 'evil one.'"—
. Neubauer. Quoted by Bishop of Durham.

"*Imprimis usurpatur de diabolo.*" "It is especially used for the devil."—Dr. Payne Smith; also quoted by Bishop of Durham as a higher authority.

"*A malo.*" Indefinite, masculine or neuter.—Leusden's translation (Amsterdam, 1717), an edition of high character.

From "evil."—Translated by Rev. Dr. Murdock, Professor of Ecclesiastical History, New Haven, U.S.

From "the evil."—Etheridge's translation of the Syriac Gospels. Longmans & Co.

From "the evil."—CURETON's translation of the Syriac Gospels. Probably the most ancient version. London.

HARKLEIAN or PHILOXENIAN SYRAIC. Sixth century. "From evil" or "from the evil." Translated by Rev. Dr. Malan.

OLD LATIN, before the time of Jerome, probably early in the second or third century.

Codex Veronensis—"*A malo.*"—(In Verona.)

Codex Brixianum—"*A malo.*"—(In Brescia.)

Codex Vercellensis—"*A malo.*"—Attributed to Eusebius, Bishop of Vercellensis, and Martyr.

Codex Corbeiensis—"*A malo.*"

Codex Aureus—"Ante Hyeronimum."—"*A malo.*"

These are all indefinite, and according to classical usage, and the authority of St. Augustine, and of the later Latin Church, they mean from "evil" generally.*

EGYPTIAN or COPTIC, two different versions.

SAHIDIC or THEBAIC, the version of Upper Egypt, probably late in the second or early in the third century. It has *p—poneros*—"the evil one," masculine. The Greek article του is changed into the Coptic article *p*, and the Greek indefinite πονηρου is changed into the masculine πονηρος. This masculine translation is scarcely challenged.

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* See the Bishop of Durham's rejoinder upon this, p. 294.

MEMPHITIC, or the version of Lower Egypt, probably of a somewhat later date, but still early in the third century.

pi—pet—hôou "is altogether ambiguous."—Bishop of Durham.

It is "the word which I believe it (the Memphitic) uses invariably to render το πονηρον the neuter."—Canon Cook.

The VULGATE, by St. Jerome, in the fourth century, who says that he saw the original MS. of St. Matthew's Gospel in the possession of the Monks of Bethlehem, where he translated so large a portion of the version that bears his name.

LIBERA NOS A MALO. Indefinite, masculine or neuter.

The LATIN FATHERS, and especially St. Augustine, unquestionably support "evil" generally.

AUTHORITATIVE INTERPRETATIONS by the Latin Church. There are *three* of special weight.

1st. The RHEIMS Version of the New Testament in English, which translates it "Deliver us from evil" (general evil).

2nd. A beautiful 4to edition, edited by Rev. G. L. Haydock and Very Rev. Dr. Husenbeth, published by Henry & Co., London, with notes, and the general approbation of Cardinal Wiseman and all the Roman Catholic Hierarchy of England, Scotland and Wales; and also a smaller 8vo edition, published by Duffy, of Dublin, with notes, and the approbation of the Irish Roman Catholic Hierarchy, both give "evil" generally as the translation, but add in the footnotes that του πονηρου *admits* of being translated "the evil one."

3rd. The most authoritative exposition is undoubtedly the CATECHISM OF THE COUNCIL OF TRENT (translated by the Very Rev. Dr. Donovan, Domestic Chaplain to Pope Gregory XVI., and one of the Professors in Maynooth College.—Dublin, Duffy, and also at 22, Paternoster Row, London, 1867). This catechism sums up a long and exhaustive discussion on the subject of the Lord's prayer by these words (Part iv., chap. xvi., question vii., p. 501), "The Church interprets this petition, both in the Mass and the Litanies, thus—viz., that in it we pray to be delivered from all evils, past, present, and to come."

ÆTHIOPIC (perhaps fourth century, perhaps sixth or seventh) is the authorised version in the Abyssinian Church. It has, "Deliver us from all evil." This is not disputed, and its use in that sense in the present day is confirmed by the Rev. Dr. Stern, who was for so many years a missionary and a prisoner in Abyssinia, and whose captivity occasioned our war with that country. He adds, in a letter, that it is now quite a dead language, and although it is still read officially in the churches, few even of the priests understand it. Amharic, which is the vernacular of Abyssinia at the present time, is not allowed to be used in the public services of the Church.

GOTHIC, fourth century, translated from the Greek by Bishop Ulphilas—"*Als thamma ubilin,*" "from the evil,"—indefinite. *Ubilin* is both an adjective and a noun, and may mean in this case either "evil" generally, or "the evil thing," or "the evil person" (*thamma* is the definite article).

Armenian, fifth century, called by La Croze "the Queen of Versions," because of the extreme care with which it was made at first from the Syriac, and was afterwards revised and corrected from the Greek. (*Bible of Every Land*, Bagster, p. 77.) The ancient Armenian has no articles, such as we see in Greek and other European languages, but a letter (Z), corresponding with the English N, or Greek ν, is added to nouns or adjectives, and in this latter case it corresponds with the neuter gender. From an examination of one MS. of the ninth century, and five others of the tenth, twelfth and thirteenth centuries, in the British Museum, and a further examination of two editions of the Armenian Testament, printed in Venice, also in the British Museum, the Rev. Dr. Barronian, an accomplished Armenian scholar, has favoured me with the following result:—

Matt. vi. 13, *i tcharen* abl. = from *the* evil.

"The most ancient MSS. generally possess the final N—the article—and so also do the two Venice editions, but in more modern times they begin to show the word without the N—the article. Thus the MS. of the ninth century, in the British Museum, reads *i tcharen, the* evil, but all the others read *i tchare,* without the N. The most ancient Armenian Version is therefore definitely neuter, and the more modern versions are "evil," without the article. The Bishop Khosrov Antzivadsi, of the tenth century, in his *Commentary on the Armenian Liturgy*, read *i tcharen, with* the article, and he explains the phrase as "from all the snares diabolic;" but in the Armenian Liturgy, in one of the prayers offered by the priest, it reads *i. tchare*, without the article.

GEORGIAN. "Deliver us from evil" generally. This version is of doubtful age, but was commenced, it is said, in the sixth century, and certainly completed in the eighth, the translation being unquestionably made from Greek MSS. of the Constantinopolitan family. This version would be of great value if it were not that, owing to the political troubles and the unsettled state of the Caucasus for many centuries, portions of it were lost, and they were replaced by re-translations from the Slavonic—so that it is not always certain what is original Georgian and what is of Slavonic colouring. (Bagster's *Bible of All Lands*, p. 354.) Such as it is, the translation of the St. Petersburg edition, 1818, given by the Rev. S. C. Malan (said by the Arabic Professor at Cambridge to be the most competent Georgian scholar in England), is "Deliver us from evil" generally.

ARABIC, eighth century. MSS. of this date can scarcely be said to exist (gathered from Bagster's *Bible of All Lands*), but several printed editions have been made at different periods, from such MSS. as are still in existence, and the following is from the version published by the Propaganda in Rome, in 1671:—*Lâkin najji-nâ mina el-shirrîri*, which is translated by Professor Wright, Professor of Arabic, Cambridge, "but deliver us from the evil one." He accompanied his translation by an explanatory letter, saying, "*Shirrîr* is only a stronger form of *Sharir;* the latter means *evil*, *wicked*, the former "very evil, "very wicked."

This version, therefore, of ancient date, but uncertain authenticity, favours the personal sense by the use of the word, "the *very* wicked." As a version it is not highly esteemed by the Mahommedans to whom it may be known, because of the vulgarity and inelegance of its Arabic.—Bagster's *Bible of All Lands*, p. 51.

"The Arabic versions are many, though of the slightest possible critical importance."—Scrivener, "Introduction," p. 281, 1st ed.

An edition of the entire New Testament was printed in Leyden by Espinus, in 1616, and it is translated by the Rev. S. C. Malan, "Deliver us from *the* evil." Again another edition, said to be from the Greek and Egyptian (Coptic) versions (Walton's Polyglot, 1657), is translated by Malan "from *the* evil."

SLAVONIC, tenth century, translated from the Greek by St. Cyril and St. Methodus, Greek missionaries in Russia. This is often said to be the most literal translation known. It is still the only one used by authority in the public services in the Russian churches, although the language is so obsolete as to be unintelligible to many Russians at the present day. This Slavonic version unquestionably supports the personal interpretation of the petition. It was made by two Greek missionaries in the tenth century, and it doubtless reproduces faithfully the interpretation that was traditional in the Greek Church at that time.

OLD SLAVONIC. "*Ot lukavago*" is translated "from the deceiver" (a word for the devil), by R. R. Martineau, Esq., Librarian British Museum.

MODERN RUSSIAN. "*No izbair nos ob lukavago.*" Masculine. “But deliver us from the evil one.”—Mrs. Orchar, an English lady, for twenty years resident in Russia; the translation confirmed by the late Rev. A. Whishaw, a native of Russia, who adds—“from evil” would be “*ot lonkavstoo.*”

MODERN VERSIONS AND CATECHISMS.

All post-Reformation except*. Some of these modern versions, are made from the Vulgate, and reflect the indefinite or neutral character of that version. Others, like our own Authorised Version, were made from the Greek; and it is not without interest in this question to observe how other scholars, as well as the Revisers, have understood and translated the words in dispute. The absence of uniformity in the translations shows that there has been no slavish traditional interpretation on one side only, while the general consensus in favour of “from evil” is not without weight.

VERSIONS.	ORIGIN.	DATE.	TRANSLATION.
*Anglo-Saxon.	Vulgate.	8th cy.	“of yfele.”
*Wicliff.	Vulgate.	1380.	“from yuel.”
Tyndale.	Greek.	1534.	“from evell.”
Geneva.	Greek.	1557.	“from evil,” “from the Euyl.” (Luke xi. 4.)
Authorised English.	Greek.	1611.	“from evil.”

English Church Catechism:—“Defend us in all dangers, ghostly and bodily; from all sin and wickedness; from our ghostly enemy, and from everlasting death.”

Rheims, Author. R.C.	Vulgate.	1582.	“from evil.”
*German (High.)	Vulgate.	1483.	“*sunder erlose uns von ubel,*” “from evil”

VERSIONS.	ORIGIN.	DATE.	TRANSLATION.
*German (Low).		1494.	"*Loese uns von quade.*" "from evil, harm, danger."
Ditto (Luther).	Greek.	1522.	"*von dem ubel*," "from the evil" (the definite article does not give a personal meaning).

Lutheran Catechism.—"From all evil of body and soul, and in our dying hour grant us a happy end, and take us to himself in heaven."

VERSIONS.	ORIGIN.	DATE.	TRANSLATION.
Belgian.		1639.	"*van den boozen*," damage, harm, evil.
†Danish (Michaelis).	Vulgate.	1524.	"from the evil," neuter.
†Do. (Royal Commiss.)	Luther's Germ.	1550.	"from evil."
†Do. Authorised	Greek.	1647.	"*fra det onde*," "from the evil," neuter.
†Icelandic. (Archbp. Svaning).	Vulgate.	1540.	"*frelsa oss fra illa*," "from evil."
†Ditto (Authorised). (Bishp. Thorlakson).	"A faithful version of Luther's German."	1584.	"*af illu*," "from evil," neuter.
†Norwegian.		1550.	The Danish Bible is the "Authorised" in Norway.
†Swedish (Synod of Stockholm).	"Luther's compared with the Greek."	1617.	"Fräds oss ifran ondo," "from evil."
Dutch.§	Greek, authd. by States General and Synod of Dort.	1618.	"*van den booze*," "masculine or neuter, but always understood to be the devil."

Dutch Catechism.—"Deliver us not only from the devil, but evil in general."—§ Rev. H. Pierson, Zetten, Holland.

† The text and the translations were kindly given by the Rev. Dr. Mourier, per Dr. Giersing, of Copenhagen; the "origin" of the versions was obtained from *The Bible of All Lands*. Bagster.

VERSIONS.	ORIGIN.	DATE.	TRANSLATION.
French, Port Royal, or De Sacy's.	Vulgate.	1668.	“*du mal,*” from evil, (for Roman Catholics chiefly).
French, Osterwald's.		1774.	“*du Malin,*” from the evil one (for Protestants chiefly).
Italian, Diodati.	Greek.	1641.	“*dal Maligno,*” from the evil one.
Italian, Martini.	Vulgate.	1769.	“*dal male,*” from evil.
Spanish, Scio's.	Vulgate.	1798.	“*de mal,*” from evil.
*Catalan.	Vulgate.	1407.	“*do quasevol mal,*” from whatever evil.
Portuguese.	Greek and Vulgate.	1781.	“*do mal,*” from evil.
Welsh, Salesbury.	Greek.	1567.	“*di rhaedrwc,*” } us from
Welsh, Modern.	Greek.	1620.	“*ni rhag drwg,*” } evil. “No possibility of making it a person.”—Rev. Dr. Thomas, the most learned Welsh scholar in Liverpool.
Irish, Bedell's.	English Auth V. compared with the Greek and Diodati's Italn.	1640.	“*inn ó olc,*” us from evil, “any badness,” not “the evil one.”—Mr. O'Loghlin.
Tamil, or Malabaric.	Greek.	1840.	“*timen*” “fault, sin, mischief, harm, injury.”—R. Rost, Esq., Library, India Office.
Hebrew, Delitzch, Greenfield.	Greek.		הָרָע *horong,* “evil in the abstract. When used in the masculine sense, it never means the evil *one* (the devil), but the evil person.”—Rev. Dr. Stern, Minister of the Synagogue, Hope Place, Liverpool.

The *internal evidence* seems strongly to favour "evil" generally, for all the petitions are *general* and *im*personal:—

Our Father, thy name be hallowed, our trespasses forgive us.
thy kingdom come, into temptation (trial) lead us not.
thy will be done, (πειρασμον)
our daily bread give us, *from evil* deliver us.

But if the petition is read, "deliver us from the devil ("the evil one"), it is at variance with the character of the rest of the prayer in its personal and limited application: for while "evil" includes the author of evil as well as his works, there are many "evils," such as sickness, accidents, and the like, from which we are taught to pray for deliverance, that cannot be considered as being the works of the devil.

If, then, the Jews who originally heard the prayer "could not think for a moment of the devil" when told to pray for deliverance from evil; if the Greek itself is indefinite, and the nearest approach to the original language (the Syriac) is indefinite also; if one Egyptian version is definitely masculine while the other is claimed as definitely neuter, or is acknowledged to be indefinite; and if all the ancient versions favour evil generally or are indefinite, except the Arabic, which "is of the slightest possible critical value," and the Slavonic, which is of the tenth century; if all the authoritative catechetical explanations, both eastern and western, ancient and modern, teach that the prayer means deliverance from evil of all kinds; and the modern versions, with scarcely an exception, translate the Greek into "evil" or "*the* evil," but not "the evil *one*"; and if the translation of this petition into the limited, personal "evil one" is at variance with the whole character of the rest of the prayer, the evidence seems to be overwhelmingly in favour of the original translation, "evil" generally, and against "the evil *one*," which has been substituted in the Revised Version of the Lord's Prayer.

CONCLUSION.

The general result of our review of the Revised Version is the following:—

That many of the long-acknowledged faults or defects in the Authorised Version have been corrected, and the translation in the Revised Version has now been brought into more accurate harmony with the original, the force and meaning of which are rendered more clear by the changes in many places, and liability to misconception is removed in others.

That the extreme literalness of the Revised Version will be a valuable help to students of the New Testament, while at the same time it has involved numerous changes and departures from English idiom that are much to be regretted; for the excessive number of changes made, as the result of this extreme literalness, and of rules self-imposed by the Revisionists, have not been called for by "faithfulness" or "necessity" in the sense of the instructions given by Convocation, and are likely to prejudice the reader and operate against the acceptance of the Revised Version as a substitute for the Authorised Version.

That the numerous changes in the Greek text, sometimes noted, but more frequently adopted into the Revised Version without notice, and the doubt thrown by marginal notes upon other portions which are still retained unaltered, are much to be regretted in a work like the New Testament, which is placed before learned and unlearned readers alike, without any means being supplied for solving their doubts; *and the question has still to be settled, whether in accepting the testimony of ℵ and B as practically conclusive of the text, the Revisers have adopted the most faithful witnesses to the sacred words or only the oldest MSS. at present known.*

But that, in spite of all the alterations called for by carping criticism, by anxious, loving care, by passing theories of interpretation, or by simple solicitude for critical accuracy, the New Testament is substantially unchanged in vital particulars; and if, for example, a Mahomedan, a Parsee, or a follower of Confucius or Buddha should desire to learn for himself what Christianity is from its own sacred books, it would be practically immaterial whether the Authorised or the Revised Version was placed in his hands. In both alike he would find the same Christ, and from either of them he would learn the same ground for the Christian's hopes, and the same rules for the Christian's conduct.

ON INDIVIDUAL VARIATION AMONG ASCIDIANS.

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The specific determination of Ascidians has always been found a matter of considerable difficulty, on account of the apparent absence of reliable characteristics in many of the so-called species.

Most of the older descriptions in which only the external appearance is taken into consideration are useless, owing to the great effect which surrounding circumstances have upon the shape of an Ascidian; while even now, when we describe minutely the structure of all the more important internal organs, in some cases it seems almost impossible to find good specific characters, and to discriminate between species and varieties. The cause of this is the great amount of individual variation—the considerable difference in the anatomy of individuals admitted to belong to the same "species." My attention was first drawn to this point when I began to examine critically the "Challenger" collection of Tunicata, and I soon perceived the necessity of satisfying myself, as far as possible, as to the relative values of the specific characters generally made use of, and as to the extent of individual variation. In order to determine these points, I examined a large number of specimens of several of our common British Ascidians, and the results of part of my investigations have already been published. A first paper, read before the Royal

Physical Society of Edinburgh,* treated of the "olfactory" or dorsal tubercle only. This I found to be a very variable organ, and of comparatively little value as a specific character. In a second paper, read before the Linnæan Society of London,† I discussed the branchial sac, an organ which is considered of primary importance in specification, but which, in the case of some species at least, is liable to vary considerably. *Styela grossularia*, v. Ben.,‡ was one of the most interesting species which I examined, on account of its great variability and of the remarkable modification of the longitudinal folds so characteristic of the branchial sac in the Cynthiidæ and Molgulidæ. Recently I have made some additional observations upon this species, which are, I think, of sufficient morphological interest to warrant me in laying them before this Society.

One of the characters of the family Cynthiidæ, to which *Styela* belongs, is that the branchial sac is thrown into a number (up to twenty-four, twelve on each side of the sac) of longitudinal folds, projecting internally. In the genus *Styela* the normal number of such folds is eight, four on each side, and in most of the species they are large, project considerably into the cavity of the sac, and lie with their crests directed towards the dorsal edge of the sac, along which runs a median membranous fold, the dorsal lamina (see Pl. I., Fig. 1, I., II., III., IV., branchial folds; D.L. dorsal lamina). On these folds the vessels known as "internal longitudinal bars" are much more numerous than on the spaces between the folds, and they are especially closely placed near the middle line or crest of the fold.

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* See Proc. Roy. Phys. Soc., Edin., vol. vi., p. 254, 1881.

† See Journ. Linn. Soc., vol. xv., p. 274.

‡ This is one of our most common British forms, and on some parts of the coast is very plentiful between tide marks and in a few fathoms of water. Although variable in appearance as well as internal structure, still it is usually easily recognisable. It was first described by Van Beneden in 1847 (*Mém. de l'Acad. Roy. de Belgique*, t. xx.), and was noted as British by Alder in 1848. (See also *British Mollusca*, vol. i., p. 40.) Previously it had been considered as the young of *Styela rustica*, O. F. Müller.

In some species of *Styela* (*e.g.*, *Styela flava* and *Styela oblonga*) the folds are in a rudimentary condition. They do not project into the interior of the sac, or at most form merely low rounded ridges, whose position is chiefly indicated by the increased number of internal longitudinal bars, so that these folds may be described as longitudinal tracts along which the bars are crowded together (see Pl. I., Fig. 2, I., II., III., IV.).

In *Styela grossularia* there is apparently only a single fold in the branchial sac. It lies on the right side of the sac, near the dorsal edge, and is in a rather rudimentary condition, being merely a low rounded projection, on which there are a number of closely-placed internal longitudinal bars (see Pl. I., Fig. 3 *br.f.*). The rest of the branchial sac is perfectly flat. But a careful examination of this area reveals an arrangement of the internal longitudinal bars which I believe indicates the position of the missing folds, and shows the stages through which a fold may pass in becoming obsolete.

As a rule, in branchial sacs, the internal longitudinal bars are equidistant, and form by their intersection with the "transverse" vessels rows of quadrangular meshes, which are approximately equal in size in any species, and contain the same number of stigmata; and in branchial sacs which are folded, and have consequently tracts along which the internal longitudinal bars are closely placed and the meshes narrow, the spaces between the folds, as a rule, have the bars equidistant and the meshes of one size. This, however, is not the case in *Styela grossularia*. If the branchial sac be removed, slit down the centre of the endostyle, which marks the ventral edge, and laid out on a slide, the following features will be easily recognised: 1st, the dorsal lamina, a narrow membrane, running down the centre of the dorsal wall, and projecting into the interior of the sac; 2nd, the fold placed on the right side, near the dorsal lamina, and separated from it by an area twice or thrice as broad as an ordinary mesh, and not traversed by any bars; 3rd, the remainder of the branchial sac, apparently destitute of folds, but divided by the internal longitudinal bars into rows of meshes which are not all equal, but are seen to be distinctly of two sizes, the larger of which is twice or thrice as wide as the smaller. The smaller meshes are placed two or three rows together, and are simply tracts along which the internal longitudinal bars are more closely placed than elsewhere. These tracts represent, I believe, the missing folds. In the great majority of the sacs examined they were separated by two or three rows of the larger meshes, and seven of them were present, three on the right side, where the single fold is placed, and four on the left side, where there is no fold, thus completing the eight characteristic of the genus *Styela*. Sometimes the most ventrally placed tracts of narrow meshes, those next the endostyle on each side, are either absent or reduced to a single row of meshes each. This was to be expected as, even in Ascidians with well-developed branchial folds, the pair next the endostyle are smaller than the others, and occasionally rudimentary.

The larger meshes contain usually six or seven stigmata,* (Pl. II., fig. 1), but as many as eight have been noticed, and sometimes there are only five. The smaller meshes have usually three or two (rarely one or four) stigmata each (Pl. II., fig. 1.) There are four rows of very much larger meshes in the sac, one on each side of the dorsal lamina, and one on each side of the endostyle. These contain usually sixteen to eighteen stigmata, but the number may descend as low as twelve or, in one case, ten; on the other hand, it may rise to twenty or, in one case, twenty-three. On the right side of the sac the dorsal row of wide meshes is followed by the branchial fold, which is traversed by usually eight or nine internal longitudinal bars (Pl. II., fig. 2); the number rarely exceeds this; ten was noticed only once or twice, and no greater number was met with; a smaller number of bars is, however, sometimes, present, and it may fall as low as four or five, in which case the fold is exactly like one of the longitudinal tracts of smaller meshes. (Pl. II., fig. 4.)

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* As the stigmata are approximately equal, the width of the meshes may be measured by the number of stigmata they contain.

On the left side of the sac, immediately following the dorsal row of wide meshes, and consequently in the corresponding position to the fold on the right side, is a series of about four closely-placed internal longitudinal bars forming three rows of narrow meshes. (See Pl. I., fig. 4, I.) That these rows represent a fold there can be no doubt. They occupy exactly the position of one of the missing folds, and have the same structure as the fold on the right side in its more rudimentary condition; hence we may safely consider them as the dorsal or first rudimentary fold on the left side. Following this are usually two, sometimes three, rows of wide meshes, containing each six or seven stigmata, and representing the space of normal meshes between two folds. This space is bounded ventrally by the second rudimentary fold of the left side, which generally consists of two rows of narrow meshes, containing each two or three stigmata. Beyond these rows on the ventral side is the second space between folds represented by two rows of wide meshes, and followed by the third rudimentary fold of the left side, a series of two rows of narrow meshes. Then comes the last space between folds consisting of either two or three rows of wide meshes, and bounded ventrally by the fourth and last rudimentary fold of the left side, which is frequently represented by a single row of narrow meshes, and may be entirely absent in some parts of the sac, on account of one of the internal longitudinal bars being broken in these places, and thus allowing the smaller meshes to communicate with the adjoining larger ones. This last fold is separated from the endostyle which marks the ventral edge of the sac by the ventral series of very wide meshes, which contain twelve to sixteen stigmata each.

The right side of the sac has, near the dorsal edge, the one well-marked fold which has been already described; and then the second, third, and fourth folds of the right side, which are all rudimentary, and have exactly the same structure as the corresponding series of meshes on the left side. The spaces between these folds are also usually exactly similar to those which have been described for the left side of the branchial sac.

Such is the normal condition of the branchial sac in this species, judging from the specimens I have examined, but it is liable to great variations, and scarcely two individuals are exactly alike, while in many there are great differences in structure; in the series of individuals examined I have found nearly every stage between the well-developed projecting first fold on the right side, with nine or ten rows of narrow meshes, and the very rudimentary fourth fold on the left side, consisting of a single row of narrow meshes, interrupted here and there, so as to leave not even the slightest indication of a fold.*

The accompanying chart (Plate I.) shows some of these variations diagrammatically. Each of the long lines (in Figs. 4–9) represents a horizontal section through a branchial sac which has been slit up along the bottom of the groove of the endostyle, and spread out in one plain. The central dorsal line of each sac is marked by the projecting dorsal lamina (D.L.), while the cut ventral edges are each indicated by one of the ridges of the endostyle (En.); consequently, as the interior of each sac is supposed to be facing downwards, the right-hand half of the sheet contains the left sides of the branchial sacs, and the left-hand half the right sides. The first fold on the right side, when well developed, is shown by a curved projection of the wall of the sac (I. *br.f.* in Fig. 4), while the rudimentary folds are indicated by the Roman numerals I., II., III., and IV. The short lines directed downwards from the wall of the branchial sac represent internal longitudinal bars, and divide the interior of the sac into meshes. The numbers (16, 2, 6, 8, &c.) placed above show the number of stigmata, and thus indicate the relative sizes of the meshes.

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* I should add that all the branchial sacs described in this paper are from adult individuals with fully developed genital organs, consequently, none of the irregularities can be due to immaturity.

In figure 4, a typical branchial sac, such as has been described above, is represented. The dorsal lamina (D.L.) is followed by an area sixteen stigmata wide on each side, The first right fold (I. *br.f.*) is well developed, and has nine internal longitudinal bars, while the fold opposite to it, on the left side, is represented by four rows of narrow meshes, or, in other words, has five internal longitudinal bars. The other folds (II., III., IV. on each side) are in the usual rudimentary condition, being formed of two rows of narrow meshes each. They are separated by pairs of rows of wider meshes, containing each six, seven, or eight stigmata, and the IV. fold on each side is separated from the endostyle by a still wider area (ten or twelve stigmata). The other five sacs given in the chart (figures 5-9) are abnormal, and show some of the more common variations from the typical arrangement.

Figure 5 has the first right fold well developed (ten internal longitudinal bars), and separated from the dorsal lamina by a considerable interval (eighteen stigmata). The second right fold (II.) is formed of two rows of narrow meshes (two and four stigmata), and is separated from the first right fold by a very wide interval (three rows of wide meshes). The third right fold (III.) is represented by a single row of narrow meshes, and the fourth is entirely absent. Its position (indicated by X in the diagram) is obviously after the two rows of wide meshes following III. It would then be separated from the endostyle by a space twelve or thirteen stigmata wide. The left side of this branchial sac has the three first folds well shown, while the fourth (IV.) is almost obsolete. In some parts of the sac it is represented by a single row of narrow meshes (two stigmata), but as the bars bounding these meshes fail here and there, the narrow meshes are thrown into the adjoining wider ones, and the fold disappears. In the figure the number of stigmata is enclosed in brackets, to show the partial nature of the row of meshes.

Figure 6 shows rather an irregular sac. The first right fold is well developed (eight bars), and separated from the dorsal lamina by a wide interval, while the first left fold (three rows of narrow meshes) has only an ordinary wide mesh (six stigmata) between it and the dorsal lamina. The second, third, and fourth folds on the right side form a series leading towards extinction; II. has two rows of narrow meshes, III. has a single row, while IV. is represented by a partial row only. The spaces alternating with these folds are rather narrow, being only five, four, and five stigmata wide, respectively. On the left side of the sac the single rows of narrow meshes representing the second and fourth folds are partial only, while the third fold (III.) is clearly shown by two rows of narrow meshes (two and three stigmata). The I. and II. and the II. and III. folds are separated by narrow intervals of five stigmata each, while the III. and IV. are separated by two rows of five stigmata, and the IV. is divided from the endostyle by two rows of meshes, first a row of ordinary wide meshes (six stigmata), and then the usual much wider interval (sixteen stigmata).

Figure 7 shows a sac where the folds have almost entirely disappeared, with the exception of the first on the right side, which, as usual, is well developed. The second and third on the same side are represented by a single partial row of narrow meshes each; the fourth may have been present, but as the ventral edge of the sac was torn, the diagram could not be completed; the fourth left fold was also not seen. The first and third left are formed each of a single row of narrow meshes, while the second (II.) is only partially present. On both sides of this sac the spaces between the folds are well represented and comparatively wide, forming a contrast in this respect to the last sac examined (Fig. 6).

Figure 8 shows a very remarkable case where at first sight the folds seem to be entirely absent. The first right (I.) does not project, and is indicated merely by five rows of very narrow meshes (containing each one or two stigmata). Extending from this to the endostyle is a series of wide meshes, and one naturally supposes at first that the remaining folds on the right side are obsolete. When, however, the stigmata are counted, and the sizes of the meshes compared, it becomes evident that six of them form two series, a larger and a smaller, placed alternately, while the seventh is the largest of all, and separates the most ventral of the smaller meshes from the endostyle. The series of smaller meshes has six, six, five stigmata, while the three larger ones have each eight; but, although there is only this slight difference in size, I think there can be no doubt that the three narrower rows represent the three missing folds (II., III., and IV.), while the three wider rows are the spaces between them.

The first left fold has two rows of narrow meshes (three and five stigmata), and is separated from the dorsal lamina by twelve stigmata. The rest of this half of the sac resembles the corresponding region on the right side. The second, third, and fourth folds are represented by single rows of meshes, five, six, and five stigmata wide respectively, while they are separated by rows of wider meshes (nine or ten, eight, and seven stigmata); the fourth is separated from the endostyle by a space of twelve stigmata.

Figure 9 gives only one-half of the sac (the right side), and is brought in to show a condition of the first fold even more rudimentary than in figure 8. As in that sac, it does not project internally, and is composed of five rows of narrow meshes, but these meshes are wider than those of the sac shown in figure 8; they contain each two or three stigmata, and are precisely like the rows of narrow meshes in the rudimentary folds.

The remaining folds on this side of the sac (II., III., and IV.) are represented each by a single row of narrow meshes (three stigmata), and they alternate with single rows of wider meshes (seven, six, five stigmata). The fourth is separated from the endostyle by a space of ten to twelve stigmata in width.

In conclusion, there are two points which I think this investigation has brought out clearly.

1. The immense variability which may exist within the limits of a single species in the details of structure of an important organ like the branchial sac.

2. The continuous series connecting a well-developed branchial fold (such as I. on the right side, in figures 4 and 5) with the most rudimentary indication of where the fold ought to be. Figures 4-9 show examples of all stages between these extremes. Commencing with I., on the right in figure 5, we pass through the corresponding folds in figures 4, 7, and 6 to figure 8, where there is no projection, but the bars are still close; then to figure 9, where the bars are more

open and the meshes of the same size as in I. on the left in figure 4. Then we pass to I. on the left in figures 5 and 6, where there are only three rows of narrow meshes; then through two rows and a single row, both of which are well represented in the diagrams, to a single row extending only part of the way, as in IV. on the left, figure 5, and IV. on the right, figure 6. Then the step is short to the last stage, shown at X. in figure 5, where fold IV. on the right is entirely absent.

EXPLANATION OF THE PLATES.

PLATE I.—Chart of Diagrams (page .)

Fig. 1. Diagram of transverse section of branchial sac of *Styela grandis.*

Fig. 2. Diagram of transverse section of branchial sac of *Styela oblonga.*

Fig. 3. Diagram of transverse section of branchial sac of *Styéla grossularia.*

Fig. 4. Diagram of a typical branchial sac of *Styela grossularia.*

Figs. 5–9. Diagrams of branchial sacs of *Styela grossularia,* showing some of the more important variations.

D. L.—Dorsal lamina.
En.—Endostyle.
I., II., III., IV.—The branchial folds.

PLATE II.—All the figures represent parts of the branchial sac of *Styela grossularia,* van Beneden, seen from the interior.

Fig. 1. A part showing the alternating series of wide and narrow meshes.

Fig. 2. The right dorsal region, showing a well-developed first right fold.

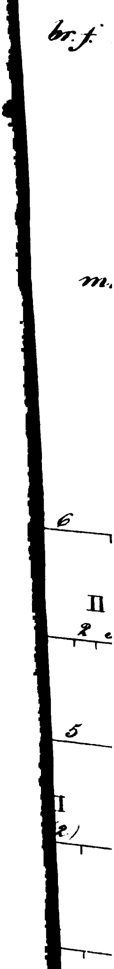
Fig. 3. A part showing an almost rudimentary fold where the internal longitudinal bars stop, and the rows of narrow meshes are only partial.

Fig. 4. A feebly-developed first right fold, where there is no projection, and only four rows of narrow meshes.

br.f.—branchial fold.
i.l.—internal longitudinal bar.

tr.—transverse vessel.
tr'.—smaller intermediate transverse vessel.
mh.—ordinary wide mesh.
mh'.—narrow mesh in the fold.
sg.—stigma.

All the figures are enlarged about thirty times, and were drawn seen through Swift's 1-inch objective.



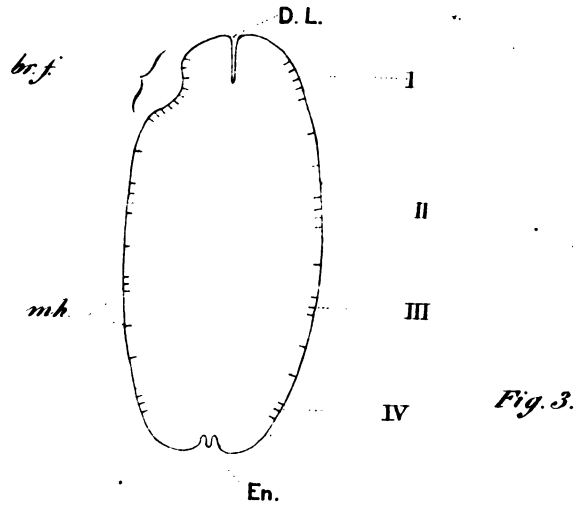
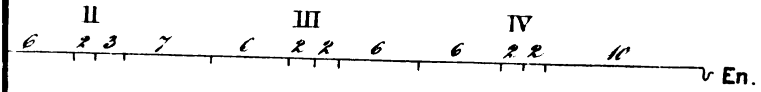


Fig. 3.



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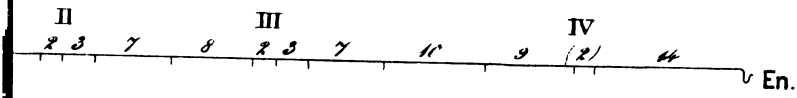

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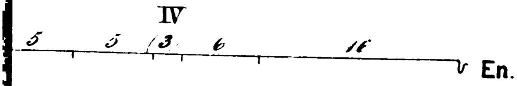
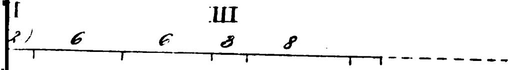


Fig. 6.



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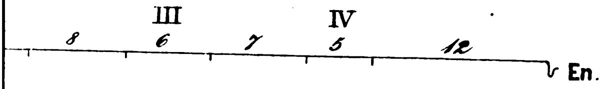

Fig. 8.

Left Side.

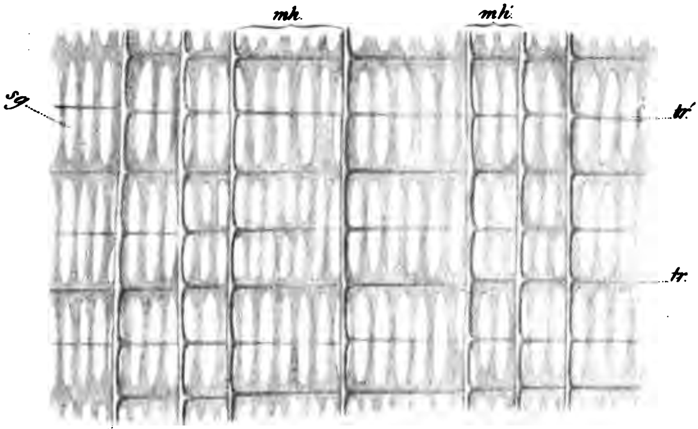

Fig. 1.

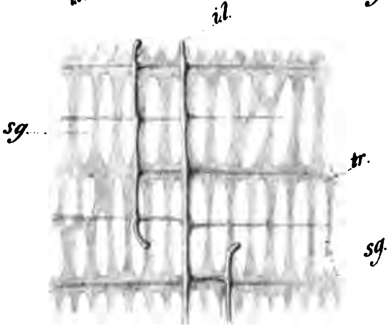

Fig. 3.

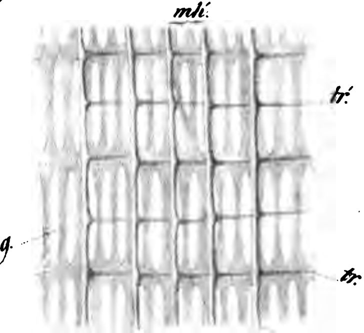

Fig. 4.

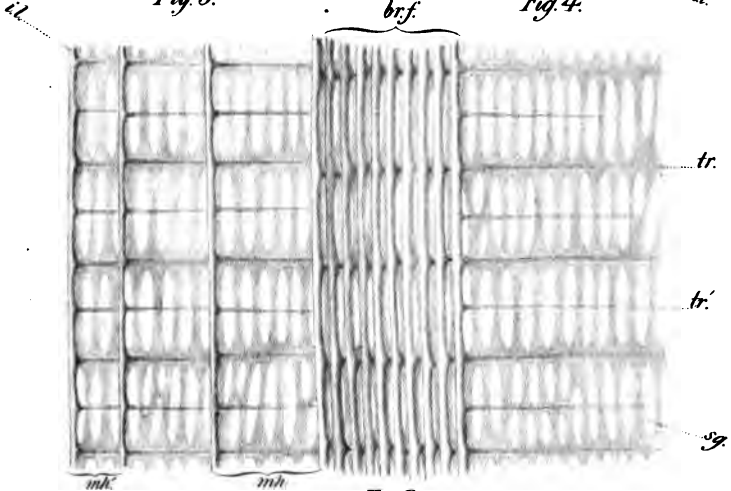

Fig. 2.

W. A. Herdman. del.

METAMORPHOSES OF LEPIDOPTERA

FROM SANTO PAULO, BRAZIL,

IN THE FREE PUBLIC MUSEUM, LIVERPOOL.

BY

E. DUKINFIELD JONES, C.E.,

CORRESPONDING MEMBER, LIT. AND PHIL. SOC., L'POOL.

WITH NOMENCLATURE AND DESCRIPTIONS OF NEW FORMS

By FREDERIC MOORE, F.Z.S.

AND

AN INTRODUCTORY NOTE

By T. J. MOORE, C.M.Z.S.L.,

CURATOR OF THE MUSEUM.

INTRODUCTORY NOTE.

Some few years since Mr. Dukinfield Jones, a young Civil Engineer of Liverpool, called at the Museum for the purpose of naming a small collection of Moths and Butterflies which he had collected during a recent professional visit to Brazil. Calling to mind the numerous collections of a similar kind brought home by travellers or sent from the country for mere trade purposes, I took the liberty of suggesting to him, that instead of confining his attention, on his proposed return to Brazil, to procuring and preserving Lepidoptera in their perfect state, he would obtain much more satisfactory results by collecting and studying their metamorphoses. The occupation would be in itself far more interesting, with much greater promise of additions to knowledge.

This seed of suggestion fell on good ground, as the Society is already aware from communications which I have had the honour and pleasure of bringing from time to time before its meetings. The present communication is further evidence of its author's zeal and diligence in cultivating the field suggested to him; but by no means displays all that he has accomplished. In a letter dated March 13, 1881, announcing the shipment of the collection, he makes the following statement:—

"I regret that I have had to hurry greatly over the descriptions. You will probably observe that they are nothing more than dates of pupation, &c., from No. XXX, or thereabouts, to the end. I found the time was getting so short that I should not have finished them at all if I had written each as fully as I did at first. The present series does not profess to include more than the full-fed larva, the pupa, and the imago. I hope hereafter I may have more time to devote to the subject, and work out the changes from the egg to the perfect insect. It has been very tantalizing to me this season to have to neglect so many caterpillars from want of leisure for feeding them. And not only this, but my work requiring me sometimes in the town and sometimes up in the hills, prevents my keeping any living creatures at either place, for they would be sure to be left without food some time or other.

"I have tried collecting specimens and transferring them to trees in the neighbourhood of my ranch, so that I could look at them without having to keep them in the house. But the results have not been satisfactory; for the larva were sure to get full-fed and wander away whilst I was in town.

"You will see that the Nos. of the species are not consecutive; for instance, Nos. V, VI, VIII, XI, XII, &c., do not appear. This is because I have not all the species in all three stages, having perhaps found only one specimen of the caterpillar, and kept it to work through the metamorphoses. These species I hope to send you at some future time, if I am fortunate enough to find specimens to complete the series.

"I have now worked out eighty-three species, and have some pupæ now that I am anxiously watching to see what new glory they will produce."

The present paper includes forty-six species, five of which are believed to be new to science. The total of eighty-three species worked out by the author's own unaided exertions in two or three years whilst busily engaged in laborious professional duties, compares not unfavourably with the results obtained in the same line of research conducted under the far more favourable conditions of a high official position, abundant help, artistic and otherwise, and (it is not uncharitable to suppose) the smaller amount of high-pressure prevalent when this century was young. I allude to the instance I had in mind when I gave the advice mentioned at the commencement of this note; namely, to the collection of Metamorphoses of the Lepidoptera of Java made by the late Dr. Horsfield between the years 1813 to 1819, one of the most extensive on record, yet falling short of 200 species. (See *Catalogue of the Lepidopterous Insects in the Museum of the Hon. East India Company.* By Thomas Horsfield, M. and Ph.D., F.R.S., and Frederic Moore. Vols. 1 and 2, 1857–9. London, Wm. H. Allen & Co., wherein a large number of these metamorphoses are figured and described.)

Dr. Horsfield records in his "Catalogue" how he fitted up a large apartment adjoining his residence with breeding-cages and receptacles for chrysalides; how he went out daily in search of caterpillars, accompanied by his most intelligent native assistants, several of whom were told off to provide suitable daily food, to watch the caterpillars and their changes, and to submit them in due time and season to the draughtsman. He also relates the elaborate means taken to secure the identity of each individual through all its varied changes. Equal labour and care was in every instance required in reference to the present collection, and all had to be done by the author single-handed. To testify that it has been done with the utmost care and exactness is my bounden duty.

It remains only to state that the larva, pupa, and imago of a species when worked out was indicated by the same Roman numeral; that a separate sheet of paper was devoted to each species and bore the same number; this in the order in which the species was worked out, and having no reference to ultimate scientific arrangement. The critical determination of the species has, at the recommendation of the Rev. H. H. Higgins, been intrusted by the Library and Museum Committee to my brother, who strongly recommends that drawings of *all* the larvæ and pupæ, and especially the new species, should be published, a luxury much to be desired, but not now, at any rate, to be indulged in. I am grateful that the Society and the Library and Museum Committee have done so much; the Society in this publication; the Committee in providing so handsomely for the display of the collection; and to Mr. Dukinfield Jones for so liberally presenting it to the Museum. My only regret is that, owing to his continued residence in Brazil, I have not had the benefit of Mr. Jones's assistance in seeing his manuscripts, &c., through the press.

T. J. MOORE.

SYSTEMATIC ARRANGEMENT.

Rhopalocera.

Family Nymphalidæ.

Subfam. *Danainæ.*

LXII.—Danais Erippus.
XXV.—Mechantis Lysimnia.

Subfam. *Morphinæ.*

XLI.—Morpho Hercules.
III.—Morpho Epistrophis.

Subfam. *Brassolinæ.*

XXXIV.—Brassolis Astyra.
XIX.—Opsiphanes Glycerie.

Subfam. *Acræinæ.*

XV.—Acræa Pellenea.
LXXXII.—Acræa Alalia, variety.

Subfam. *Heliconiinæ.*

LXIX.—Eueides Dianasa.

Subfam. *Nymphalinæ.*

LIII.—Junonia Cænia.
VII.—Ageronia Amphinome.

Family Papilionidæ.

Subfam. *Pierinæ.*

XXIV.—Catopsilia Philea.

Subfam. *Papilioninæ.*

XXXI.—Papilio Thoas.
XLV.—Papilio Grayi.
XXXVIII.—Papilio Evander.
XLII.—Papilio Lysithous.

Family Hesperiidæ.

XXI.—Pyrrhopyga Palemon.
LIV.—Goniuris Proteus.

Heterocera.

Family Sphingidæ.

LV.—Dilophonota Ello.
LXI.—Argeus Labruscæ.
XXVIII.—Pachylia inornata.
XIII.—Sorocaba anomala.

Family Chalcosiidæ.

LXXII.—Phæochlæna tendinosa.

Family Arctiidæ.

XXX.—Daritis sacrifica.
XLVI.—Motada lateralis.

Family ————?

XXXIII.—Perophora albistriga.
IX.—Perophora externa.

Family Notodontidæ.

XXIX.—Aneurocampa lateralis.

Family Saturniidæ.

I.—Automeris sp?
II.—Automeris Metea.
XX.—Molippa Sabina.
LXXV.—Arsenura erythrinæ.
LX.—Attacus Aurota.

Family Limacodidæ.

LXVII.—Pinconia ochracea.
LXXX.—Neomiressa argentata.
LXXIX.—Narosa rufotessellata.

Family Lasiocampidæ.

IV.—Eacles Laocoon.
XVII.—Megalopyge Citri.
XXXV.—Megalopyge dorsimacula.
LXXXI.—Megalopyge sp?
XL.—Megalopyge Tharops.
XXVII.—Hydrias Deusta.

Family Glottulidæ.

LVII.—Cabralia trifasciata.

Family Apamiidæ.

L.—Prodenia Commelinæ.
Prodenia variolosa.

Family Calpidæ.

LII.—Gonodonta fulvangula.

Family Remigiidæ.

LI.—Remigia mensuralis.

F. MOORE.

METAMORPHOSES OF BRAZILIAN LEPIDOPTERA.

RHOPALOCERA.

Family NYMPHALIDÆ.

Subfam. *Danainæ.*

LXII.—DANAIS ERIPPUS.

Papilio Erippus, Cramer, Pap. Exot. i. pl. 3, fig. A. B. (1775).
Papilio Archippus, Fabricius, Ent. Syst. iii. p. 49 (1793).
Smith, Abbott, Ins. Georgia, i., pl. 6.

LARVA. *a,* Full-fed. Santo Paulo, March 6, 1880.

The caterpillar feeds on a species of Asclepias, and is found full-fed at the end of February. (See fig. I, plate VI.)

PUPA. *a,* March, 1880.

When full-fed the caterpillar suspends itself by the tail, and in that position changes to the beautiful pale green chrysalis, ornamented with a ring of gold round the abdomen and gold spots on other parts of the body.

IMAGO. *a, b.*

The butterfly appears a fortnight after the caterpillar is full-fed.

XXV.—MECHANITIS LYSIMNIA.

Papilio Lysimnia, Fabricius, Ent. Syst. iii. i. p. 161 (1793).
Hübner, Zutr. Exot. Schmett. fig. 187–8.

OVA.

The beautiful white eggs are laid in clusters of about a dozen on the upper surface of the leaf of a species of Solanum on which the caterpillar feeds. I have sometimes found the eggs on the underside of the leaf also.

LARVA. *a*, Full-fed. Santo Paulo, May 30, 1878.

Caterpillars that emerged from the egg on April 22nd, 1878, were full-fed on May 30th. The colour is a dull white with a bluish tinge, and there is an orange mark at the joints of the segments; on each side of the segments there is a long fleshy protuberance. They are very sluggish in their habits, and are to be found in clusters on the underside of the leaves of the Solanum.

PUPA. *a*, Hatched, Ap. 22; Full-fed, May 30; Imago, June 22, 1878; Pupation, 23 days.
b, *c*, May, 1878.

When full-fed the caterpillars hang themselves up by the tail in a cluster on the underside of the leaf, and one of these families of chrysalids after the change has taken place is a lovely sight. The appearance is that of pure burnished gold, which in the sunshine is dazzlingly beautiful. A couple of days before the butterfly emerges, the markings of its wings become very visible through the delicate shell of the pupa, and the latter becomes shaded with dark steel blue and the prismatic colours of tempered steel.

IMAGO.	*a*, Full-fed,	May 10;	Imago,	June 2, 1878	= 23 days.
	b, ,,	,,	,,	,,	,,
	c, ,,	May 11;	,,	June 3,	,,

The butterfly appears about three weeks after pupation. It is a very common species, and flies in shady places in woods and campos. The flight is slow and graceful, and the fly is constantly settling upon the leaves of the trees, where it stays slowly opening and shutting its wings.

Subfam. *Morphinæ.*

XLI.—MORPHO HERCULES.

Papilio Hercules, Dalmann, Anal. Ent. p. 40 (1823).

LARVA. *a*, Full-fed. Santo Paulo, Dec. 20, 1878.

The caterpillars were found on the stem of a "cipo," or climber, on the Serra da Cantareira, near Santo Paulo, on Dec. 16th, 1878. They were in a cluster of about twenty individuals. The colour is brick-red, with tufts of black and of white hairs in rings round the segments. The black hairs are barbed, and cause a good deal of irritation if one gets them between one's fingers. The caterpillar has a disagreeable smoky sort of smell, something like that of No. III. (*Morpho Epistrophis*), but at the same time quite distinct.

PUPA. *a*, January, 1881.

On Dec. 20th some of the specimens were full-fed, and became of a dull greenish colour. They hung themselves up by the tail, and in a few days changed to the robust green chrysalis. The chrysalis is marked with a white bloom, especially on the wing-cases, which bloom easily rubs off. (See fig. 2, plate III.)

IMAGO.
a, ♂ Full-fed, Dec. 20, 1878; Imago, Feb. 8, 1879 = 50 days.
b, ♂ Jan. 31, 1881. *c*, ♀ Jan. 31, 1881.
d, ♀ Feb. 12, 1881.

The splendid imagos appeared at the beginning of February, being in the pupa state about seven weeks. These grand butterflies are very common at the Cantareira, where they sail about in hundreds on a hot day. Sometimes half-a-dozen will be seen in a group, chasing one another round and round, or having a dance with one of their pearly cousins, *M. Epistrophis*.

III.—MORPHO EPISTROPHIS.

Leonte Epistrophis, Hübner, Samml. Exot. Schmett. (1816–24.)

OVA.

The eggs of this species are laid in clusters of twenty or thirty on the upper side of the leaf of the food plant, and incubate in about fifteen days.

LARVA. { *a*, Full-fed. Santo Paulo, Dec., 1878.
b, Cast skins Dec., 1879.

After emerging from the egg, the young caterpillars are very sluggish, and apparently do not move at all for a couple of days. For some weeks after they are hatched they scarcely eat anything, and do not seem to grow at all. They lie in a cluster on the under side of the leaf, radiating from a centre, their great black heads pointing outwards and presenting a very curious appearance. They probably hybernate during the cold season, for I have found specimens at the end of July still very small. The food plants that I have found the caterpillar upon are all forest trees, two of them belonging to the Papilionaceæ.

The caterpillars are social, and hang in a cluster on a leaf of the tree quite close together, and very beautiful they look with their intricate mosaic markings and soft downy hair. At night they separate to feed, returning to the same leaf in the morning, which leaf is covered with a silken web to give security to their hold. When walking they have a curious habit of wagging the head up and down. I have noticed the same habit in other caterpillars, but the motion is generally from side to side. The object of this wagging of the head seems to be to drive the preceding caterpillar on when the brood is marching in single file to its feeding ground, or back to its resting place, for I have only observed this habit in those caterpillars that live in clusters. The whole lot of caterpillars, walking close one after the other, wag their heads in this way to touch up the "tail" of the individual in front of each, the effect being very comical. I have found, when changing them to new food, that the only way to get them to move was to imitate this movement of the head with my finger applied to their tails. If the caterpillars were in their resting position, I could generally start the whole regiment by tickling the hindermost ones, who in their turn stirred up those in front, till they all got on the move.

The caterpillar has a very unpleasant and peculiar odour that is quite indescribable. The mandibles are very powerful, and are capable of giving a severe bite if their owner is annoyed. In eating, the noise of the crunching of the leaves is considerable.

When full-fed the caterpillar hangs itself up by the "tail," the size diminishes, and the bright colours become dull and suffused with a greenish grey colour. They are full-fed in December.

PUPA. { *a*, In spirit, immediately after change.
b, Dry. Full-fed Dec. 12, 1877. Imago, Jan. 23, 1878 = 42 days.

Pupation takes place three days after the larva is full-fed. The pupa is of a beautiful bright green, the venation of the wings, etc., being of a darker shade. The insect remains in this state for six weeks.

IMAGO. { *a*, ♂, Feb., 1879.
b, ♂, Full-fed, Jan.; Imago, Feb. 7, 1879.
c, ♀, Feb., 1879.
d, ♀, Full-fed, Dec. 30, 1878; Imago, Feb. 8, 1879 = 40 days.

These exquisite butterflies begin to make their appearance at the end of January, but do not appear in large quantities till the middle of February; the earlier specimens are all males. From the middle of February till the end of March the woods about Santo Paulo literally swarm with these lovely insects; sometimes four or five will be seen circling round and round, or lazily flapping their great pearly wings in the bright sunshine, rather sailing than flying. By the end of April they have all disappeared.

There is only one brood of this butterfly in the year.

Subfam. *Brassolinæ.*

XXXIV.—BRASSOLIS ASTYRA.

Brassolis Astyra, Godart, Enc. Meth. ix., p. 457 (1823). Boisd. Spec. Gén. Lep. i., pl. 13, fig. 2. Doubleday and Hewits, D. Lep. pl. 59, fig. 1.

Castnia Langsdorfii, Ménetries, Nouv. Mem. Mosc. i., p. 192, pl. 5 (1829).

LARVA.
- *a*, Full-fed, Santo Paulo, Oct., 1878.
- *b*, Taken from web lining flower spathe of species of palm. The web contained over four hundred caterpillars.

The caterpillar is social, living in a web spun either in the flower spathe or amongst the leaves of a species of palm. The number of individuals in one web is sometimes enormous. I have found a web spun across a flower spathe containing, as above, over four hundred caterpillars. In the day time they are to be found closely packed within the web, which is very thick and impervious to rain, and at night they pour out and feed. I have seen large palm trees completely stripped of their leaves by this caterpillar. It is full-fed at the end of October and beginning of November.

PUPA. *a*, Full-fed, Oct. 17, 1878; Imago, .

When full-fed the caterpillar descends the palm-tree, and searches for a convenient spot for undergoing the change, such as the underside of the branch of a tree, the coping of a wall, etc. It then spins the web ready to hook on to when changed to the pupa state, and remains for three or four days attached by the anal and last pair of abdominal legs; it then leaves-go with the abdominal and hangs by the anal legs alone for one or two days, when it changes to the chrysalis. (See fig. 3, plate III.)

IMAGO. *a, b, c*, Dec. 5–14, 1877.

The butterfly makes its appearance at the beginning of December. It is crepuscular in its habits, never flying till about sunset. The flight is powerful and rapid. Groups of five or six males and one female may often be seen flying backwards and forwards, and occasionally settling on a branch of a tree.

There is only one brood of this butterfly in the year.

XIX.—OPSIPHANES GLYCERIE.

Papilio Glycerie, Fabricius, Mant. Ins. ii., p. 36 (1787). Clerck, Icones, pl. 34, fig. 3, 4, ♀.

Potamis S. Cassiæ, Hübner, Samml. Exot. Schmett., pl. 75, f. 3, 4, ♀.

LARVA. { *a*, Full-fed specimen and one other. Santo Paulo, April 10, 1878.

This extraordinary caterpillar feeds on the leaves of the banana. In the first stage it is pale yellow, with black head covered with curious flat hairs, and the diverging horns on the last segment are also black, with a single long hair on the point. After the first change of skin, the head becomes of a pale pinkish grey colour, and is furnished with eight horny excrescences, four on each side, the four anterior ones much shorter than the posterior. On the last segment the black appendages also change to the same colour as the head. In the last stage the caterpillar is striped longitudinally with pale blue and green, the stripes being separated from one another by narrow yellowish brown lines, and the horns on the head and last segment are greatly developed, giving the insect a very strange appearance. The caterpillar always lies close alongside of the mid-rib of the leaf, and, from its close resemblance to the colour of it, is very difficult to see at a short distance. It spins a fine white web on the leaf, to help it to hold on, and always spins a web in front of it when walking. (See figs. 4, 5, plate III.)

PUPA. { *a*, Full-fed, April 13; Imago, May 10, 1878 = 27 days.

When full-fed, the caterpillar attaches itself to the underside of the mid-rib of the banana leaf by its anal and last pair of abdominal legs, the thorax hanging down. In this position it remains two days. The third day it lets go with the abdominal legs, and hangs by the anal ones only, or by its "tail," as it is generally expressed. At the close of the third day it changes to a pale green chrysalis, with a dot of gold on each wing-case. (See fig. 6, plate III.)

IMAGO. { *a*, ♀ Full-fed April 13; Imago, May 10, 1878 = 27 days.
b, ♀ April 27, 1878. *c*, ♂ April 23, 1878.

This butterfly is crepuscular in its habits, and is rarely seen flying in the daytime. The best time for it is just after sundown, when it may be seen flying in the open glades of woods, etc., settling on some elevated point, and from thence sallying forth in pursuit of its fellows. The flight is quick and powerful, and it is difficult to capture except when resting. There is a musky smell about this butterfly.

Subfam. *Acræinæ.*

XV.—ACRÆA PELLENEA.

Actinote Pellenea, Hübner, Zutr. Exot. Schmett. fig. 741–2 (1832).

LARVA. *a,* Full-fed. Santo Paulo, March, 14, 1878.

The caterpillars feed on several composite plants, and are very plentiful at certain times of the year. They are social in their younger stages, living in a cluster on a loose web. In the last two stages they are not exactly social, but may be found in great quantities on the same plant. The general appearance of the caterpillars is much the same in all the stages. The spines do not appear to have urticating properties. The caterpillars are very hardy, and I have often noticed them covered with hoar-frost in the early mornings in August and September. There appear to be two distinct broods in the year, but the period of any stage extends over a considerable time.

PUPA. *a,* Full-fed, Mar. 1; Imago, Mar. 13, 1878 = 12 days.

When full-fed the caterpillar suspends itself by the "tail" to the underside of a leaf or the coping of a wall or other shelter, and there undergoes pupation. (See fig. 7, plate IV.)

IMAGO. *a, b.*

Specimens full-fed 28th February, 1878, changed March 1st, and the butterflies appeared on March 13th. This fly is one of the commonest in the neighbourhood of Santo Paulo; sometimes the air quite swarms with them.

LXXXII.—ACRÆA ALALIA (Variety).

Acræa Alalia, Felder, Wien. Ent. Monats. iv., p. 105 (1860).

LARVA. *a,* Full-fed.. Santo Paulo, Jan. 16, 1881.

The caterpillar was found on a large leaf, like that of the horse-radish, growing in a swamp.

PUPA. {*a*, Feb., 1881.
b, Full-fed, Jan. 17; Imago, Jan. 31, 1881 = 14 days.

The caterpillar hangs itself up by the tail to change to the pupa state.

IMAGO. *a*, ♂ *b*, ♀.

The butterfly appears fourteen days after the larva is full-fed.

[NOTE.—This variety differs from a typically marked specimen in the British Museum Collection, in the forewing of both sexes having a broader medial transverse blackish area, owing to the absence of the red spot between the base of the upper and middle median veins, and the small size of the spot between the middle and lower median veins. The hindwing differs also, in having a broader medial angular transverse black area, and a broader black outer marginal band.—*F. Moore.*]

Subfam. *Heliconiinæ.*

LXIX.—EUEIDES DIANASA.

Nereis Dianasa, Hübner, Samml. Exot. Schmett. (1806–16).

LARVA. *a*, Full-fed. Santo Paulo, April 25, 1880.

The caterpillar feeds on a species of Passion-flower, and was found full-fed at the end of April, 1880.

PUPA. {*a*, Full-fed, April 24; Imago, May 14, 1880 = 20 days.

The caterpillar suspends itself by the tail to undergo pupation. The chrysalis is a very remarkable one, being covered with long excrescences, four of which on the back of the thorax are arranged in the form of a cross. It is also remarkable for the faculty of making a squeaking noise when annoyed. This is done by violent jerks of the abdominal rings, the sliding of one ring over the other causing the noise. The sound is very like that made by the Longicorn beetles.

IMAGO. { *a*, Full-fed, April 24; Imago, May 14, 1880 = 20 days.

The butterfly appears about three weeks after the caterpillar is full-fed.

Subfam. *Nymphalinæ.*

LIII.—JUNONIA CŒNIA.

Junonia Cœnia, Hübner, Samml. Exot. Schmett. (1816-24).
Vanessa Cœnia, Boisduval & Leconte, Lep. Amer. Sept. p. 182, pl. 49.

LARVA. *a*, Full-fed. Santo Paulo, Jan. 19, 1880.

This beautiful caterpillar feeds on a species of Anterrhinum. It is covered with branched spines springing from beautiful dark blue shiny tubercles, that sparkle in the sunshine like gems. The spines do not appear to have any venomous properties.

PUPA. *a*, Full-fed, Jan. 29; Imago, Feb. 8, 1880 = 10 days.

When full-fed the larva suspends itself by the tail, and changes to a robust, slightly spiky, chrysalis.

IMAGO. *a*, *b*, *c*, *d*.

The butterfly appears three weeks after the caterpillar is full-fed.

VII.—AGERONIA AMPHINOME.

Papilio Amphinome, Linn. Syst. Nat. i. 2, p. 779 (1767).
Cramer, Pap. Exot. i., pl. 54, fig E. F.

LARVA. { *a*, Penultimate stage. Santo Paulo, March 14, 1880.
b, Full-fed. Santo Paulo, March 19, 1880.

I have only found this caterpillar in the penultimate and last stages. In the former stage it is black, and is covered with spines, and has two curious horns on the head. In the last stage the colour changes, the central segments (fourth to ninth inclusive) becoming a light brown colour, beautifully marked with an intricate black pattern. The spines on these segments are of the same colour, only tipped with black; the rest of the segments remain black, and the horns on the head are much larger than in the former stage. The food plant is a climber that is plentiful in the woods and copses round Santo Paulo. The caterpillar is remarkably active in its habits, and gives one the idea of being in a hurry all his life. He never seems to walk, but is always on the run. In eating the same hurry is observed, as if he was afraid he would not get enough before he had to pupate. The slightest shake of the leaf or stem of the plant makes the caterpillars fall to the ground. The spines are venomous, but the poison seems weak in its effects.

PUPA. { *a*, Full-fed, Feb. 21, 1878. Imago, March 4 = 12 days.
b, Santo Paulo, March, 1880.

Specimens of the caterpillar in my possession were full-fed on Feb. 21st, 1878, and they suspended themselves by the "tail." On Feb. 22nd they changed into the remarkable chrysalis with the two horn-like processes on the head. These processes do not form till the pupa has emerged completely from the skin of the larva, and securely hooked itself to the silk that the larva has spun for this purpose. As soon as this is done the pupa remains perfectly still, and the horns begin to grow. They grow in the manner of a stocking being turned inside out; when half-grown the end can be distinctly observed moving up the inside. The whole operation takes place in about two minutes. The pupa is remarkable for the great difference in the colouring of individuals.

Out of ten specimens in my possession, eight were of a dark smoky colour, with green patches on the wing covers, and on the back of the thorax, while two were almost all green beneath and the dark smoke colour on the back. The horns in all the specimens were of a burnt-sienna colour, shaded with smoke. The difference in colouring does not appear to be sexual, but I am not able to state with certainty whether it is or not. (See fig. 8, pl. IV.)

IMAGO. *a, b, c, d,* March, 1880.

On March 4th the perfect insect appeared, eleven days after the larva was full-fed.

The butterfly settles on the trunks of trees in the forest with the head downwards, taking short and rapid flights every now and then, especially when other butterflies are passing, which it delights in chasing. When thus employed it often emits loud crackling sounds, very like electric sparks. It rarely flies excepting in bright sunshine.

Family PAPILIONIDÆ.

Subfam. *Pierinæ.*

XXIV.—CATOPSILIA PHILEA.

Papilio Philea, Linn. Syst. Nat. i. 2, p. 764 (1767). Cramer, Pap. Exot. ii., pl. 173, fig. E. F. Donovan, Ins. China, pl. 32, fig. 2.

Catopsilia Philea, Butler, Lep. Exot. p. 92, pl. 35, fig. 1–4 (1872).

LARVA. *a,* Full-fed. Santo Paulo, April 20, 1878.

The caterpillar feeds on the flowers of a species of Cassia, and its colour so closely resembles that of the brilliant yellow flowers that it is impossible to detect it at a short distance. Some of the individuals have dark green tubercles in rings round the segments, others are entirely yellow. This difference in colouring does not appear to be sexual. Specimens taken in April, 1878, were full-fed on the 20th of that month.

PUPA. { a, Full-fed, April 23; Imago, May 14, 1878=21 days.

When full-fed the caterpillar attaches itself by the "tail" and a loop round the thorax to a twig or other suitable object, and next day changes to the chrysalis. The chrysalis is generally of a pale opaque greenish colour, with the veins of a lighter shade and tinged with yellow. Two of my specimens, instead of being green, were of a beautiful purplish pink, the veins being of the same colour as in the green specimens. This difference of colouring is not sexual, for one of the specimens was a male and the other a female. (See fig. 9, plate IV.)

IMAGO. {
a, ♂ Full-fed, April 23; Imago, May 18, 1878=25 days.
b, ♂ May, 1878. c, ♀ June 4, 1878.
d, ♀ Full-fed, April 24; Imago, May 18, 1878= 24 days.

The butterfly appears about three weeks after pupation. After emerging they remain a long time without attempting to fly. I have observed specimens that did not leave the spot for five days, remaining perfectly still all the time.

Subfam. *Papilioninæ*.

XXXI.—PAPILIO THOAS.

Papilio Thoas, Linn. Mant. Plant. p. 536 (1771), Drury, Illust. Exot. Ent. i., pl. 22, fig. 1, 2 (1773). Cramer, Pap. Exot. ii., pl. 167, fig. A. B.

OVA.

The eggs are laid singly on the upper surface of the young leaves of the orange, on which the caterpillar feeds. They are spheroidal in shape, and dull orange colour.

Larva. *a*, Full-fed. Santo Paulo, April 20, 1878.

The strange-looking caterpillar is very sluggish in its habits, remaining for hours on the leaf without moving. It has a shiny skin that gives it the appearance of being wet, and is clammy to the touch. When annoyed it protrudes two bright orange-coloured tentacles from the prothoracic segment, which have a pungent and disagreeable odour, a tiny drop of colourless liquid forming at the end of each tentacle. The odour of the liquid is so strong that if it gets upon one's hands it takes a good deal of washing to get rid of it.

Pupa. *a*, Full-fed, March 23, 1878.

When full-fed the caterpillar fixes itself by the "tail" and by a loop round the thorax to a branch of the tree, the head being uppermost, and in that position it changes to the remarkable chrysalis resembling a rotten twig broken off short.

Imago.	*a*, ♂	Full-fed, Ap. 30;	Imago, Sep. 29, '78	= 152 dys.
	b,	„ „ 23	„ Oct. 20, '78	= 180 „
	c,	„ „ 23	„ „ 25, '78	= 185 „
	d,	„ „ 30	„ „ 26, '78	= 179 „

Specimens full-fed in April, 1878, produced butterflies in August, September, and October. There appear to be two broods in the year.

XLV.—Papilio Grayi.

Papilio Grayi, Boisduval, Spec. Gén. Lep. i., p. 365 (1836).
Chenu, Encycl. Pap. pl. 16, fig. 2 (1857).

Larva. *a*, Full-fed. Santo Paulo, April 10, 1879.

In the early stages this caterpillar closely resembles that of No. XXXI, *Papilio Thoas;* but after the last change of skin the appearance is quite altered. In this stage it is very handsome. The colour of the back is a sort of sage green. On the third segment is a crescent of brown having several beautiful purplish crimson spots; on the ninth segment two bands of the same brown colour cross one another on the back, and are dotted with purplish crimson. There are dots of the same colour along the sides. The caterpillar possesses a pair of scent organs, which are protruded when it is annoyed. (See fig. 10, plate IV.)

PUPA. *a*, April, 1880.

Specimens in my possession were full-fed 10th April, 1879, and they attached themselves to the sides of the box in the same manner as No. XXXVIII, *Papilio Evander*, the chrysalis of which species they much resemble.

IMAGO. *a*, ♂ Full-fed, Ap. 8; Imago, Sept. 22, 1879=167 days.
b, Feb., 1878; *c*, —.

The butterfly appears in September, being more than five months in the pupa state.

XXXVIII.—PAPILIO EVANDER.

Papilio Evander, Godart, Encycl. Méth. ix., p. 32 (1819). Swainson, Zool. Illust. ii., pl. 101. Boisd. Spec. Gén Lep. i., p. 277.

LARVA. *a*, Full-fed. Santo Paulo, Jan. 1, 1879.

I found a cluster of forty or fifty of these caterpillars on the trunk of a Tangierine orange tree on December 30th, 1878. At night they separated to feed, returning to the same spot next day. The scent organ is very large, and the odour very strong. I observed that the caterpillar had the faculty of even flinging a tiny drop of fluid from the ends of the organs on to my finger when I touched its back. The fluid has a very disagreeable and pungent smell, and it takes more than one good scrub with soap and water to get rid of it. On 1st January, 1879, more than half the cluster had disappeared, and I captured about a dozen specimens.

PUPA. *a*, Jan., 1879.

The same day that I captured the caterpillars some of them fixed themselves to the sides of the box I kept them in, and the next day they changed to the chrysalis, resembling a rotten twig of the orange; but curiously enough I did not find a single chrysalis on the tree on which the caterpillars were feeding, nor on any of the surrounding trees. They must have dispersed to a considerable distance.

IMAGO. { *a*, Full-fed, Jan. 3; Imago, Jan. 27, 1879 = 24 dys.
b, „ Jan. 2; „ Jan. 25, 1879 = 23 dys.

On January 24th the first butterfly made its appearance, having been three weeks in the pupa state.

XLII.—PAPILIO LYSITHOUS.

Hectorides Lysithous, Hübner, Samml. Exot. Schmett. (1816–41).

LARVA. *a*, Full-fed. Santo Paulo, Jan. 4, 1880.

The caterpillar feeds on the leaves of the "Araticu" (Rollinia ?), and is very sluggish in its habits, spending nearly all its time perfectly still in the centre of a leaf. It possesses scent organs on the prothoracic segment, but it requires a good deal of irritation to make it exsert them. The smell is not so strong as that of Nos. XXXI and XXXVIII, *Papilio Thoas* and *P. Evander*.

PUPA. *a*, Full-fed, Jan. 4; Imago, Jan. 22, 1880 = 18 days.

The pupa is attached by its "tail" and a loop round the thorax to a twig of the tree, and from its position and colour (green, with a few rusty markings,) it looks remarkably like a little fruit. The time passed in the pupa state varies considerably.

IMAGO. { *a*, Full-fed, Jan. 4; Imago, Jan. 22, 1880 = 18 days.
b, Do. Oct. 9, 1878; „ Feb. 24, 1879 = 138 „

Specimens full-fed in October appeared as perfect insects in February. Others, full-fed in January, produced butterflies in February. I have found full-fed caterpillars at the end of February, 1881. It remains to be seen when these will produce imagos.

Family HESPERIIDÆ.

XXI.—PYRRHOPYGA PALEMON.

Papilio Palemon, Cramer, Pap. Exot. ii., pl. 131, fig. F (1779).
Hesperia Polybius, Fabr. Ent. Syst. iii., i. p. 337 (1793).
Donovan, Ins. India, pl. 51, fig. 2.

OVA.

The eggs are laid singly on the young leaves of the Guava. I have not been able to determine the time of incubation.

LARVA. *a*, First, penultimate, and full-fed stages.

When the caterpillar issues from the egg it is about five millimetres in length, and is of a purplish red colour, with bright yellow bands. The first thing it does after leaving the egg is to make a house within which to retreat when not engaged in feeding; this is done by cutting out a piece of leaf seven or eight millimetres in diameter, and fixing it on to the upper surface of the leaf in such a manner as to leave a passage for ingress and egress. When it has grown sufficiently to enable it to pull the leaves themselves together and fasten them with silk, it makes its retreat in that way. From its secluded habits it is difficult to see the changes of skin. A specimen in my possession was hatched on 25th February, 1878. On March 3rd there was a change of skin, and on March 14th another. I was not able to determine any other changes, and the caterpillar was full-fed on April 3rd. After the second (or third ?) change, the larva becomes covered with a white powder, that rubs off when touched, and the whole skin becomes finally of a dull white colour.

The caterpillar remains within the leaf during the day, and only comes out to feed at night. When annoyed by the approach of any insect, it has a curious habit of wagging its head and thorax from side to side, and sometimes round and round in a circle, striking its head against the sides of its house. The noise thus made is considerable. (See fig. 11, plate IV.)

PUPA. { *a*, Santo Paulo. Full-fed, April 3; Imago, April 28, 1878 = 25 days.

The pupa is of a pale bluish green, and is covered with the white mealy powder. It changes within the leaf, and suspends itself by the "tail" and a band round the thorax, lying on its back in a more or less horizontal position.

IMAGO. *a*, *b*.

The specimen that was full-fed on April 3rd appeared as a perfect insect on April 28th, giving a dormant period of 25 days.

At the end of June, I found other caterpillars full-fed, the butterflies of which did not appear till the end of September.

LIV.—GONIURIS PROTEUS.

Papilio Proteus, Linn. Syst. Nat. i., 2, p. 794, (1767). Smith-Abbott, Lep. Ins. Georgia, i., pl. 18. Cramer, Pap. Exot. iii., pl. 260, fig. D, E.

OVA.

The eggs are laid on the underside of the leaves of a sort of kidney-bean. They are usually in pairs. Time of incubation not observed.

LARVA. { *a*, Larger specimen, full-fed. Santo Paulo, Jan. 28, 1880.

The caterpillar protects itself with a piece of the leaf, fastened down on the upper surface of the leaf during the early stages. When large enough it bends the leaves themselves together, and makes its retreat in that way. It is pale green in colour, with longitudinal stripes of yellow.

PUPA. { *a*, Full-fed, Jan. 28; Imago, Feb. 13, 1880 = 16 days.

Pupation takes place in the same way as No. XXI., *Pyrrhopyga Palemon.*

IMAGO. { *a* and *b*, Full-fed, Jan. 29; Imago, Feb. 16, 1880 = 18 days.

The butterfly appears eighteen days after the larva is full-fed. Specimens in my possession were full-fed, as above, on 29th Jan., 1880, the imagos appearing on Feb. 16th.

HETEROCERA.

Family SPHINGIDÆ.

LV.—DILOPHONOTA ELLO.

Sphinx Ello, Linn. Mus. Lud. Ulr., p. 351 (1764). Drury, Ill. Nat. Hist. i., pl. 27, fig. 3.

Dilophonota Ello, Burmeister, Abhandl. Nat. Gesellsch. Halle, p. 70 (1855).

OVA.

The egg is laid singly on the upper surface of the Mandioca leaf. It is a flattened ovoid in shape, of a pale yellow sprinkled with rusty red.

LARVA. *a*, Full-fed. Santo Paulo, Feb. 16, 1880.

When the caterpillar issues from the egg it is about four millimetres long and pale green, with a long black horn on the last segment. The green colour is preserved through the second stage, but the length of the tail or horn is much reduced, and becomes reddish in colour. In the last stage the caterpillar is of a pinkish smoky grey, and has no horn on the last segment.

PUPA. *a*, Full-fed, Jan. 22; Imago, Feb. 18, 1880 = 27 days.

The caterpillar enters the ground to undergo pupation.

IMAGO. { *a*, Full-fed, Jan. 24; Imago, Feb. 22, 1880 = 29 days.

The moth appears four weeks after the larva enters the ground. I have observed it from the middle of February to the middle of March.

LXI.—ARGEUS LABRUSCÆ.

Sphinx Labruscæ, Linn. Mus. Lud. Ulr. p. 352 (1764).
Clerck's Icones, pl. 47, fig. 3.

LARVA. { *a*, Full-fed. Santo Paulo, Feb., 1880.
b, Ichneumonized specimen, penultimate stage, Feb., 1880.

This caterpillar feeds on the grape vine, and is remarkable for its resemblance to a snake, in the last stage. In the penultimate stage the marking is less snake-like, and there are green patches on the sides of the 5th to 10th segments. On the last segment is a long horn, curled at the end like a pig's tail. On the last change of skin this horn disappears, and its place is taken by a shiny disk. When irritated the caterpillar vibrates the horn on the disk, and, in the latter case, the effect of the flash of reflected light is very strange.

PUPA. *a*, Full-fed, Feb. 6; Imago, March 17, 1880=40 days.

The caterpillar enters the ground to undergo pupation.

IMAGO.
a, Full-fed, Feb. 22; Imago, March 28, 1880=35 days.
b, Full-fed, Feb. 17; changed, Feb. 22; Imago, March 24, 1880; pupation 31 days.

The exquisite moth appears five weeks after the caterpillar is full-fed. Specimens full-fed 17th February, 1880, produced imagos 24th March, as above.

This moth squeaks like a mouse when violently held in the fingers or otherwise irritated.

XXVIII.—PACHYLIA INORNATA.

Pachylia inornata, Clemens, Journ. Acad. Nat. Sci. Phil., p. 159 (1859).

LARVA.
a, Full-fed. Colour changed before entering the ground.
b, Full-fed. Santo Paulo, March 23, 1879.

This caterpillar feeds on a species of Ficus, a large tree much grown about Santo Paulo for ornamentation. It is full-fed in March and April. When full-fed the appearance becomes very much altered by the formation of smoky-black rings round the segments, and the duller shade of the green. (See fig. 12, 13, plate V.)

PUPA.
a, Full-fed, March 25; Imago, June 19, 1878=86 days.
b, July, 1878.

The change to the pupa state takes place in a loose cocoon, never under ground, the small particles of the surrounding earth being bound into the texture. (See fig. 14, plate V.)

IMAGO. { *a*, ♂.
b, ♀ Full-fed, March 28; Imago, June 25, 1878 = 89 days.

The moth thus appears very nearly three months after the caterpillar enters the ground.

XIII.—SOROCABA ANOMALA.

Genus nov. SOROCABA. Forewing short, rather broad and triangular; exterior margin slightly sinuous; costal vein straight; cell extending half length of the wing; first subcostal emitted at one-third before end of the cell, second trifid, third being thrown off at two-thirds from its base, and fourth at one-half from third; discocellular oblique, bent outward near upper end, radial from the angle; two upper medians from end of the cell, second from near the end, and lower at one-half before the end; submedian nearly straight, with a short basal lower branch: hindwing triangular; costa extending beyond the posterior angle of forewing, exterior margin scalloped, abdominal margin long; subcostal joined to costal at a short distance beyond the base, two subcostal branches emitted beyond the cell; discocellular bent outward in the middle, radial from the angle; middle median near end of the cell, lower at more than half before the end. Body somewhat slender; head small; palpi small, porrect, pilose beneath; antennæ bipectinate; legs thickish.

Sorocaba anomala, n. sp. Pale ochreous-brown; forewing of a greyish ochreous-brown along costal area, giving it the appearance of a broad costal paler fascia; two transverse antemedial and two postmedial slender indistinct brown sinuous lines; a small brown spot at end of the cell: hindwing and body ochreous-brown. Cilia reddish-brown, edged with ochreous-white. Expanse two inches.

LARVA cylindrical, smooth, very slightly attenuating anteriorly, head small; horn long, slender, smooth; of a pale yellowish olive colour; each segment, except the head, with five black transverse dorsal stripes, which are joined together at the posterior side and above the spiracle; beneath each spiracle is a longitudinal black streak and a slender streak on its anterior side; horn black tipped.

PUPA small; purplish-black, spiked at apex.

From the above description of the larva of this anomalous form of the Sphingidæ, it will be seen that in its markings it mimics the larva of a Danais, the resemblance being more fully carried out by the presence of the long slender horn. (See fig. 15, pl. VI.)

The genus Sorocaba is allied to Andriasa; Walker (Catal. VII., p. 1735); which is placed by that author amongst the Bombycidæ. It is also allied to Cressonia and Pseudo-smerinthus.—F. MOORE.

LARVA. *a*, Full-fed. Santo Paulo, March 3, 1878.

The caterpillars of this species were found in great numbers on a shrub on the outskirts of a wood near Santo Paulo. The horn on the last segment moves on a sort of hinge, and when the caterpillar walks it moves the horn from side to side in a grotesque manner. When touched, the caterpillar bends the horn over towards the side the disturbance comes from. The horn is quite soft, and does not appear to have any properties of defence.

PUPA. { *a*, Full-fed, March 3; Imago, March 30, 1878 = 27 days.

Pupation takes place just below the surface of the ground, a slight web, mixed with earth, being made to protect the pupa.

IMAGO. *a*, *b*.

Specimens in my possession were full-fed on 3rd March, 1878, and on 30th March the moths appeared.

Family CHALCOSIIDÆ.

LXXII.—PHÆOCHLÆNA TENDINOSA.

Phæochlæna tendinosa, Hübner, Samml. Exot. Schmett., 18, 45, fig. 89, 90; Walker, Catal. Lep. Het. B.M. ii., p. 467.

LARVA. *a*, Full-fed. Santo Paulo, June 12, 1880.

The caterpillar was found, full-fed, on a Papilionaceous tree on the Serra da Cantareira.

PUPA. *a*, Full-fed, June, ; Imago, July, 1880.

The pupa is attached by the "tail" to the upper surface of a leaf, the body resting on the leaf. From its position and appearance one would take it for a butterfly rather than a moth-pupa.

IMAGO. *a*, *b*, *c*, *d*.

The beautiful little moth appeared in July. It is a day-flier, and may be taken in hundreds on a hot day, drinking on sandy places at the sides of streams.

Family Arctiidæ.

XXX.—Daritis sacrifica.

Eucharia sacrifica, Hübner-Geyer, Zutr. Samml. Exot. Schmett. iii., fig. 473-4, ♀.

Taxila crucifera, Walker, Catal. Lep. Het. Brit. Mus. iii., p. 765, ♂ (1855).

Ova.

The eggs are laid in a cluster on the underside of the food plant, which is the same as that of No. IV., *Eacles Laocoon.* Eggs laid April 6th, 1878, were hatched April 21st.

Larva. *a*, Full-fed. Santo Paulo, July 11, 1878.

The caterpillar is social in its younger stage, but as it grows, the individuals wander about and find new feeding grounds for themselves. The appearance does not change much through the casting of skin. Specimens taken in the first stage in February, 1880, changed skin on the 9th, 14th, 20th, and 27th of that month, and were full-fed on March 6th.

Pupa. *a*,

When full-fed the caterpillar spins a light web between the stalks of the plant; or in any other convenient place, and in this undergoes pupation, which does not take place for several days after the web is spun.

Imago.
a, ♂. *b*, ♀.
c, ♀. Full-fed, July 12; Imago, Sept. 2, 1878 = 52 days.
d, ♂. Full-fed, March 6; Imago, March 24, 1880 = 18 days.

The beautiful moth emerges from the pupa from three to seven weeks after pupation. Specimens full-fed March 6th appeared March 24th. Others, full-fed in July, did not produce the imago till September. There are several broods in the year.

XLVI.—MOTADA LATERALIS.

Motada lateralis, Walker, Catal. Lep. Het. Brit. Mus. iv., p. 924 (1855).

LARVA. *a*, Full-fed. Santo Paulo, Nov. 1, 1879.

The caterpillar is covered with short hairs that cause a good deal of irritation if they get between one's fingers. It feeds on a yellow composite flowered plant, something like our Ragwort.

PUPA. *a*, Full-fed, Nov. 10; Imago, Nov. 29, 1879 = 19 days.

Pupation takes place within a rough cocoon.

IMAGO. *a*, Full-fed, Nov. 10; Imago, Nov. 29, '79 = 19 days.

Specimens full-fed 10th November, 1879, produced the moth on November 29th, as above.

Family ————?

XXXIII.—PEROPHORA ALBISTRIGA.

Pamea albistriga, Walker, Catal. Lep. Het. Brit. Mus. v., p. 1154 (1855).

LARVA. *a*, Full-fed. Santo Paulo, February, 1881.

The caterpillar of this species lives in a movable case, beautifully formed out of the leaves of the food-plant, a herbaceous plant with beautiful purple flowers (Melastoma ?). The case is slung up or rather bound up amongst the leaves with a loose web, and can be readily moved from one place to another by the caterpillar.

PUPA.

When full-fed the caterpillar closes up the ends of the case with silk, and undergoes pupation.

IMAGO.
a, Full-fed, March 26; Imago, Oct. 12, 1878 = 200 days.
b, Full-fed, March 26; Imago, Oct. 17, 1878 = 205 days.

Specimens in my possession were full-fed at the end of March, 1878, and produced the moth in October, as above stated.

IX.—PEROPHORA EXTERNA.

Perophora externa, n. sp. Male and female. Brownish grey; forewing with a transverse antemedial pale ochreous-brown angulated fascia, which also crosses the base of the hindwing; a very oblique postmedial blackish-brown line which extends to near apex, and is then acutely bent inward to the costa; this line is outwardly bordered by ochreous-brown, and followed by a submarginal brown fascia; at end of the cell is an elongated hyaline spot: hindwing with a medial transverse blackish line, continued from that on the forewing, and broadly bordered outwardly by brown. Body brownish-grey. Expanse ♂ 1¾, ♀ 2 inches.

Nearest allied to *P. orthane* and P. *vittata*, Walker. It is quite distinct from *P. sanguinolenta*, Felder.—F. MOORE.

LARVA.
a, Cases of larvæ fixed for pupation, Santo Paulo, Jan., 1878.
b, Full-fed. Santo Paulo, Dec. 11, 1877.

This caterpillar lives in a hard hammock-like case formed of the excrement, joined together with silk and mucilage. The case is suspended from the twig on which it feeds by silk threads, and is generally slung in a more or less vertical position, so that the curved end protects the upper opening from rain. Both ends of the case are alike, and the caterpillar puts his head out at either end with equal facility.

In its habits it closely resembles the allied species noticed in Proc. Lit. and Phil. Soc. of Liverpool, vol. XXXIII. p. lxxvii.

PUPA.

When full-fed the larva attaches the upper end of the case to a twig, and pupation takes place.

IMAGO. *a*, ♀ ; *b*, ♂.

Specimens in my possession were full-fed in January, 1878, and the moths appeared on 1st March.

Family NOTODONTIDÆ.

XXIX.—ANEUROCAMPA LATERALIS.

Cossus lateralis, Walker, Catal. Lep. Het. Brit. Mus. vii., p. 1520 (1856).

OVA.

The eggs are laid in a cluster round a thin twig of a species of Melastoma that is very common in swampy places round Santo Paulo. Time of incubation not observed.

LARVA. *a*, Full-fed. Santo Paulo, April 20, 1878.

I found specimens in the penultimate stage at the beginning of April, 1878. The last change of skin took place April 12th, and the caterpillars were full-fed on the 20th. (See fig. 16, pl. VI.)

PUPA. *a*, Full-fed, April 20; Imago, Aug., 1878.

The caterpillar enters the ground to pupate, and forms a tough cocoon, into which are woven small particles of earth.

IMAGO. { *a*, Full-fed, April 20; Imago, Aug. 10, 1878 = 112 days.

The specimens full-fed on April 20th, produced the perfect insect at the beginning of August.

Family Saturniidæ.

I.—Automeris sp —— ?

Automeris sp **—— ? Dull greyish sienna-brown in male, burnt sienna-red in female; forewing with a narrow transverse yellowish slightly waved antemedial band, and an oblique straight postmedial band, both bands being slenderly bordered outward with brown; a slender irregular-oval discocellular mark: hindwing with a large discal black bordered, yellow ringed, irregular circular blind ocellate patch, in the middle of which is an oval black spot, this spot being white speckled at each end, and has a contiguous white-speckled streak on each side; beyond the patch is a submarginal slender black scalloped line and a contiguous narrow red band.**

Expanse ♂ 3¼, ♀ 3¾ inches.

The above is doubtless a named species, but I have been unable to identify it.—F. Moore.

Larva. *a*, Full-fed. Santo Paulo, Dec., 1878.

The caterpillar of this species is common in the neighbourhood of Santo Paulo. There appear to be several broods in the year. It feeds on a great variety of plants. I have found it on Iris, Gladiolus, Banana, Rose, Scabious, several composite plants, and many others. It is sluggish in its habits, remaining for a long time in one spot as long as it has food. The spines are very venomous, the effects of the poison when injected into the skin being very severe, causing violent pain for some hours.

Pupa. *a*, Full-fed, Jan. 1, 1878; Imago, Jan. 31 = 30 days.

Pupation takes place in a light cocoon spun between leaves or in any other convenient place.

Imago. { *a*, ♀ Full-fed, Dec. 24, 1877; Imago, Jan. 20, 1878 = 27 days.
b, ♂ Full-fed, Jan. 1, 1878; Imago, Jan. 31, 1878 = 30 days.

Specimens as above produced the perfect insect in January, 1878. Another brood was full-fed at the beginning of April, the moths appearing at the end of that month. There is a considerable difference between the shade of the male and female, and the males also vary much in colour. I have found them almost buff and also of a deep chestnut.

II.—AUTOMERIS METEA.

Phalæna B. Metea, Cramer, Pap. Exot. iv., pl. 304, fig. A.

LARVA. *a*, Full-fed. Santo Paulo, Dec., 1877.

This species feeds upon a Solanum that grows plentifully in waste places in the neighbourhood of Santo Paulo. It is a very handsome caterpillar, the body being a deep velvety black and the tufts of spines brilliant lemon yellow. The spines are very venomous, and produce violent irritation when brought in contact with the skin.

PUPA. *a*, Full-fed, Dec. 8, 1877; Imago, Jan. 11, 1878.

Specimens in my possession in December, 1877, began to spin their dark coloured gummy cocoons on the 8th of that month between leaves of the Solanum and in the corners of the boxes. The cocoon is remarkable for the curious perforated diaphragm that closes the upper end, and through which the moth makes its escape.

IMAGO.
- *a*, ♀ Full-fed, Dec. 8, 1877; Imago, Jan. 11, 1878 = 34 days.
- *b*, ♂ Full-fed, Dec. 7, 1877; Imago, Jan. 8, 1878 = 32 days.

The perfect insects appeared from 31 to 33 days after beginning to spin. There is a great difference in the colour of the male and female, the former being of an ashen grey tinged with olive; while the latter is of a dull reddish brown. I noticed a second brood of this moth in the middle of April.

XX.—MOLIPPA SABINA.

Molippa Sabina, Walker, Catal. Lep. Het. Brit. Mus. vi., p. 1345 (1855).

LARVA. *a*, Full-fed. **Santo Paulo, March 9, 1878.**

The caterpillar feeds upon "*Unha de vacca,*" a papilionaceous tree with large white flowers. It is gregarious in its habits. In the day time it is to be found in clusters of twenty or thirty individuals on the trunk of the tree on which it feeds. At night they ascend the tree and feed, descending in the morning to the same spot. They are beautiful caterpillars, the body being ashen grey marked with black and crimson dots. It is covered with tree-like tufts of venomous spines of a whitish colour tipped with black.

After emerging from a change of skin the caterpillar goes through a series of extraordinary contortions, apparently twisting itself into knots and then undoing them. The object of this is no doubt to unfurl the spines which are of course quite soft and more or less crushed together as they come out of the old skin. I have observed the same contortions in many other spiny caterpillars. When full-fed the colour changes to a dark yellowish brownish grey.

PUPA. *a*, Santo Paulo, March, 1878.

Pupation take place within a dark brown semi-transparent cocoon spun between leaves, etc. The length of time the insect remains in the pupa state varies greatly. Some specimens that were full-fed in March, 1878, produced imagos in April; others did not appear till the middle of October.

IMAGO.
a, ♀ Full-fed, March 6; Imago, April 16, 1878 = 41 days.
b, ♂ Full-fed, March 17; Imago, Oct. 15, 1878 = 212 days.

The moth varies a good deal in colour, some specimens being shaded with a pink colour, especially in the posterior wings. When disturbed it has a habit of curling up the abdomen and erecting the wings till they nearly touch, back to back, "shamming dead."

LXXV.—ARSENURA ERYTHRINÆ.

Bombyx erythrinæ, Fabricius, Spec. Ins. ii., p. 169.

LARVA. *a*, Full-fed, April 11, 1880. Campinas.

I took the caterpillar on a species of Bombax, at Campinas, at the end of March, 1880. In the daytime it congregates in clusters on the branches of the tree, feeding at night. A friend in Campinas, from whose tree I took my specimens, told me he had killed hundreds of them time after time, to save the tree from being stripped of its leaves.

PUPA.

My specimens were full-fed early in April, and entered the ground to undergo pupation.

IMAGO. { *a*, Full-fed, April 11; Imago, Sept. 13, 1880 = 155 days.

Some of the moths made their appearance in August, others in September, and I have still (March, 1881) one pupa alive.

LX.—ATTACUS AUROTA.

Bombyx Aurotus, Fabricius, Mant. Ins. ii., p. 108.

LARVA. *a*, Full-fed. Santo Paulo, Feb. 6, 1880.

The caterpillar of this species feeds upon a shrub that grows in damp places, usually at the sides of streams or swamps. It is of a pale green colour, with small orange-coloured tufts of spines, which do not appear to have urticating properties.

PUPA. { *a*, Santo Paulo, April, 1878; contains pupæ of parasitical dipterous fly.

The change to the pupa state takes place in a beautiful pendent cocoon of excellent silk. The upper end of the cocoon is attached to a leaf or twig, and the silk is continued several inches down the twig, so that the cocoon, when torn off, has a long stalk to it.

IMAGO. *a*.

The magnificent moth appeared on 14th March, five weeks after the caterpillar was full-fed; but I believe there are many broods of this moth in the year, and the length of time spent in the pupa state probably varies a good deal.

This moth seems very liable to the attacks of a parasitical dipterous fly, many specimens of which I have bred from the cocoons.

Family LIMACODIDÆ.

LXVII.—PINCONIA OCHRACEA.

Genus nov. PINCONIA: forewing short, broad; costa convex at the end, apex almost pointed, exterior margin very oblique and convex; subcostal slightly bent at the emission of its first branch, which starts at one-third before end of the cell, trifid, the second being thrown off above the end of the cell is bent downward and then curves upward to the apex, the third being given off near its end; fourth branch bifid, emitted from end of the cell, curving upward and touching the second, fifth from one-third beyond its base; discocellular bent inward, lower end very oblique, radial from upper end of the cell; a slender discoidal veinlet emitted within the cell from angle of the discocellular; third median (or lower radial) at an angle before end of the cell below the upper, second and first (or lower) at equal one-fifth each before the end, the two last much curved; upper and lower submedians much recurved: hindwing long, almost pyriform; costal and sub-costal apparently united to near end of the cell; discocellular very oblique, bent in the middle, upper radial from the angle, lower at half way below it; a slender discoidal veinlet emitted within the cell from below upper radial; middle median at one-half and lower at two-fifths before end of the cell; submedian and internal recurved. Body pilose; palpi small, porrect, slender; antennæ (broken); legs densely pilose.

Pinconia ochracea, n. sp. Male deep yellowish-ochreous: forewing with all the veins, except the costal, dark brownish-ochreous: hindwing slightly

brighter ochreous, veins less distinct. Thorax and legs bright ochreous. Expanse 2 inches.

This insect is allied to the genus Dalcera. It also has much the appearance of *Ammallo nervosa*, Felder, but differs considerably from the latter in both the form of wings and in their venation.—F. Moore.

LARVA. *a*, Full-fed. Santo Paulo, April, 1880.

This remarkable caterpillar was found on the Ameixa (*Eriobotrya Japonica*) at the end of March, 1880. It is quite white and translucent, looking just as if made of Venetian glass. The abdominal legs are wanting, their place being indicated merely by slight swelling of the skin. The motion of the caterpillar when walking is exactly that of a slug, a series of waves passing along the surface of the abdomen, from the rear to the front.

PUPA. { *a*, Full-fed, April 12; Imago, May 6, 1880 = 24 days.

Pupation takes place within a cocoon, spun on the surface of a leaf or other suitable place. The cocoon is remarkable for the hexagonal hole left in the outer layer of silk in the centre of the cocoon.

IMAGO. { *a*, Full-fed, April 12; Imago, May 5 = 23 days.
b.

Specimens full-fed at the beginning of April, produced the perfect insect at the beginning of May. When the moth emerges, it protrudes the pupa as far as the abdomen from the cocoon, the empty shell remaining in that position.

LXXX.—NEOMIRESSA ARGENTATA.

Nyssia argentata, Walker, Catal. Lep. Het. Brit. Mus. v., p. 1134 (1855).

LARVA. *a*, Full-fed. Santo Paulo.

The caterpillar feeds on the orange, and was found full-fed in April, 1880. It is a beautiful caterpillar, being blue green, with yellow mosaic pattern on the back and four crimson spots, two on the last segment and two on the fourth segment. It is thickly covered with spines, which are extremely venomous. The appearance of the whole insect is that of Venetian glass. The abdominal legs are wanting, and the caterpillar glides along like a slug.

PUPA. *a*, Dec., 1880.

Pupation takes place in a hard, almost spherical, cocoon, spun on the upper surface of a leaf or other suitable place.

IMAGO. { *a*, Full-fed, April 13; Imago, Dec. 18, 1880 = 263 days.

The moths appeared in December. To emerge from the cocoon a circular trap door is cut, and the pupa partly protrudes through this.

LXXIX.—NAROSA RUFOTESSELLATA.

Narosa rufotessellata, n. sp. ♂ ♀. Forewing very pale yellow; crossed by seven erect blotchy-red bands, of which the basal second and outer-edge of the sixth are of a darker colour, the latter also being broadest and enclosing a similar coloured terminal spot beyond end of the cell, thus leaving a bare space before the apex: hindwing very pale red towards the inner border in male and entirely of a pale red in female; cilia pale yellow. Thorax very pale yellow, with a red collar and lower streaks; abdomen red, tuft pale yellow. Expanse ♂ $1\frac{1}{8}$, ♀ $1\frac{3}{16}$ inch.—F. MOORE.

LARVA. *a*, Full-fed. Santo Paulo, Feb. 29, 1880.

This remarkable caterpillar was found full-fed on Cedrela at the end of February, 1880. Its appearance is most grotesque. The abdominal legs are wanting, and it slides along in a slug-like manner. But instead of going steadily and smoothly it rolls from one side to the other, giving one the idea of its being drunk. From each segment project two long brown mossy-looking protuberances, which lie in a horizontal position, giving the caterpillar the appearance of a shrivelled leaf.

PUPA. *a*, Jan., 1881.

Pupation takes place in a hard black cocoon, spun on the surface of the ground at the foot of the tree. The mossy excrescences are dropped off before the cocoon is spun, and are loosely arranged on the outside of the cocoon.

IMAGO. {*a* and *b*, Full-fed, Feb. 29; Imago, Dec 14, 1880 =306 days.

The moths appeared in December, 1880. On emerging, the pupa is partly protruded through the opening in the cocoon.

Family LASIOCAMPIDÆ.

IV.—EACLES LAOCOON.

Phalæna B. Laocoon, Cramer, Pap. Exot. 11, pl. 117, fig. A, B, C, ♀.

Eacles princeps, Walker, Catal. Lep. Het. Brit. Mus. vi., p. 1374, ♂ (1855).

OVA.

The eggs of this species are laid singly on the upper side of the leaf of the food-plant, and there are seldom more than two or three on the same plant. The colour is a pale yellow, and the shape ovoid, flattened on the side attached to the leaf and the opposite side. The time of incubation I have not yet determined.

LARVA. *a*, Full-fed. Santo Paulo, Feb. 1880.

The caterpillar feeds upon a composite plant with purple flowers (Knapweed?) that grows plentifully in the campos and waste places round Santo Paulo. The colour during the first stage is black, with a light brown patch in the middle segments; the spines of the anterior segments are very long, and are terminated with a curious crescent-shaped knob. With each change of skin the colour alters considerably, the black disappearing and a brown tint taking its place; the diagonal markings along the sides become more and more distinct. After the last change of skin the colour is much the same as during the penultimate stage, but lighter in shade and suffused with a pinkish grey. The spines on the anterior segments are still very long, and have a white transparent appearance and a black tip. Their resemblance to glass is remarkable. But after a few days the pinkish grey gradually changes into bright green, and the spines diminish in length and become red. The spines are venomous, and cause considerable pain when brought in contact with the skin; but the effects are not so violent as in many other species. When annoyed the caterpillar flings its head back to strike the offending object with the spines. (See fig. 17, plate V.)

PUPA. *a*, Full-fed, Dec. 7, 1877; Imago, Jan. 17, 1878.

When full-fed the caterpillar enters the ground, and there undergoes pupation.

IMAGO.
a, ♂ Full-fed, Dec. 7, 1877; Imago, Jan. 17, 1878 = 41 days.
b, — Full-fed, Nov. 30, 1880; Changed, Dec. 6; Imago, Jan. 15, 1881 = 40 days.

The moth appears about six weeks after the caterpillar enters the ground. There is a good deal of variety in the marking of specimens. In some of the females the "death's head" on the anterior wings is very distinct.

XVII.—MEGALOPYGE CITRI.

Phalæna B. Citri, Anon. Ins. Surinam, i., p. 31, pl. 12.

Podalia Citri, Walker, Catal. Lep. Het. Brit. Mus. vii., p. 1715.

LARVA. *a*, Full-fed. Santo Paulo, March 16, 1878.

The caterpillar of this species is found, full-fed, from the middle of March to the middle of April. I have taken it on a Papilionaceous tree, called here "*Unha de Onça,*" or Puma's claws; on Cedrela, Palma Christi, a species of Ficus, and on the orange. The colour of the body is a pure dead white; the tubercles, from which spring the very long dark hairs, are of a purplish pink colour. At the roots of the long hairs are tufts of venomous spines, which cause very severe pain and inflammation if brought in contact with the skin. This caterpillar, and some others of the same genus, are so very venomous that it is dangerous to handle them, the spines even penetrating the hard skin of the fingers or palm of the hand. Most of the other venomous caterpillars can be taken up with impunity if the spines are not allowed to come in contact with the softer skin of the back of the fingers or hand.

PUPA.

The cocoons are spun in clusters about the branches of the tree, usually at a fork, and closely resemble the bark of the tree. The outer covering is very large and loose; inside this there is a second envelope, and beneath this again is the closely woven carinated case within which the insect changes to the pupa state. Pupation does not take place for several months after the caterpillar is full-fed. In August I found the larva still unchanged, though much reduced in size. Though almost motionless when I opened the cocoon, it still had activity enough to repair the damage done.

IMAGO. *a*, ♀; *b*, ♂; *c*, ♀.

The moth appears in January, having been in the dormant state ten months. There is a strong and unpleasant smell about this moth.

XXXV.—MEGALOPYGE DORSIMACULA.

Podalia dorsimacula, Walker, Catal. Lep. Het. Brit. Mus. vii., p. 1717 (1856).

LARVA. *a*, Full-fed. Santo Paulo, March 1, 1878.

This caterpillar feeds upon several plants; but I have generally found it on a Melastoma (?) For description see Proc. Lit. and Phil. Soc., Liverpool, 29th April, 1878, vol. xxxii., pp. cii.–civ. and plate.*

PUPA. *a*, Full-fed, March; Imago, Oct., 1878.

Pupation takes place within a closely spun cocoon in the outside layer of which the long red hairs of the larva are interwoven; at each end of the cocoon several small holes are left in the weaving. Pupation does not take place for a considerable time after the cocoon is spun.

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* Mr. Dukinfield Jones modestly omits all reference to his personal experience of the extremely venomous property of the spines of the larva of this insect, as related in his communication to the Society, above referred to. To test the reputed ill character given of it by the Brazilians, he experimented on himself at 11 a.m., by pressing the back of one of these caterpillars on the back of his left hand, till he could feel the prick of the spines. In ten minutes he had violent pain and swelling on the hand, and, shortly after, pain in the armpit. All his remedial measures were ineffective, and the pain was suggestive of boring with a red-hot iron. It lasted for some hours, distressed him in the night, and left a soreness which continued to the third day. The marks of the spines, thirty-six in number, were still visible more than a fortnight after. The experiment was so very convincing that I have not heard of a repetition of it. The description of the larva is as follows. "The whole body is covered with long red-brown hairs, which grow in tufts arising from the centre of each segment, and at the base of the long hairs are bunches of venomous spines, which are quite concealed by the hairs. The body is very soft and fleshy, and of a paler colour than the hairs. There are six pairs of abdominal legs, the first and last pair, however, not being fully developed. The head is very small, and is, when eating, quite covered with a fleshy mantle, formed by the first segment of the body. When walking, the head is protruded a little."—T. J. MOORE.

Imago. *a*, Full-fed, March; Imago, Oct. 28, 1878.

The moth appears in October, seven months after the larva is full-fed. This moth and other allied species have a peculiar and disagreeable odour. On emergence from the cocoon, the head and thorax of the pupa are protruded, and the empty shell will be found in that position in all cases where the moth has come out.

LXXXI.—Megalopyge sp—— ?

The specimen, a female, is too much broken for identification. It has a reddish woolly body, the wings apparently grey, with indistinct blackish streaks between the veins.—F. Moore.

Larva. *a*, Full-fed. Santo Paulo, March 16, 1878.

The caterpillar feeds on the Cedrela, and is full-fed in March. It sometimes appears in such quantities as to strip the trees of their leaves. The body is covered with beautiful bright chestnut hairs that lie in wavy ridges down the body; round the sides the hairs are black, and two curious forked black tufts of hair arise from the ends of the caterpillar. (See fig. 18, plate VI.)

Pupa. *a*, Dec., 1880.

The cocoons are spun in great clusters on the trunk of the tree, fifty or a hundred being often found in one cluster. The outside covering is thick and woolly, and inside this is formed the hard cocoon. This is ovoid in shape, with the anterior end flattened where the trap-door is formed through which the moth makes its exit.

Imago. *a*, Full-fed, March, 1880; Imago, Dec. 17, 1880.

The moth appears in December. The head and thorax of the pupa are protruded from the cocoon when the moth emerges.

The caterpillars seem very liable to disease, for I have observed that a great number die in the cocoon without pupation taking place.

XL.—MEGALOPYGE THAROPS.

Phalæna B. Tharops, Cramer, Pap. Exot. iv., pl. 359, fig. A. ♀.

Hydrias Tharops, Walker, Catal. Lep. Het. Brit. Mus. vi., p. 1404.

LARVA. { *a*, Full-fed. Santo Paulo, March, 1878, and earlier stage, March, 1881.

This remarkable caterpillar feeds upon the guava tree, and is found full-fed in March and April. It is covered with long partridge-coloured hairs, which are drawn together into a grotesque curl at the posterior end of the caterpillar. The abdominal feet are very slightly developed, and the motion is more gliding than walking. At the tubercles from which the long hairs spring there are clusters of highly venomous spines, the urticating properties of which are very great. (See fig. 19, plate VI.)

PUPA. { *a*, Full-fed, March 14, 1878; Imago, Jan. 29, 1879 = 321 days.

The cocoon is remarkable for the beautiful way in which the caterpillar adapts it to the surface it has chosen for it. One specimen in my possession spun on a twig of the guava he had been feeding upon, and he arranged his cocoon so perfectly round the twig, and ornamented it with little bits of bark so well, that at a short distance it looked exactly like a thickening of the twig. Others spun on the sides of the box, and in their case the cocoon was spread out flat. Pupation does not take place for some months after the spinning of the cocoon.

IMAGO.
a, ♂ Full-fed, March 18, 1878; Imago, Jan. 29, 1879 = 317 days.
b, ♀ Full-fed, March 15, 1878; Imago, Jan. 29, 1879 = 320 Days.

The moth appears in January, ten months after the caterpillar is full-fed.

XXVII.—HYDRIAS DEUSTA.

Hydrias Deusta, H. Schæff. Lep. Exot. Sp. Ser., pl. 19, fig. 91 (1854). Walker, Catal. Lep. Het. Brit. Mus. vi., p. 1398.

LARVA. *a*, Full-fed. Santo Paulo, April 24, 1878.

This handsome caterpillar feeds on a shrub growing in the woods around Santo Paulo. The appearance is very little altered in the different stages. Specimens in my possession changed the skin 1st March, 14th and 28th March, and 8th April, being full-fed April 24th. The caterpillars are social, passing the day in a cluster on the upper surface of a leaf, and separating at night to feed.

PUPA. *a*, Full-fed, Ap. 20; Imago, June 17, '78 = 58 days.

The cocoon is spun in any convenient spot, such as a hollow in the trunk of a tree, etc., and is remarkable on account of the skin of the caterpillar being thrust out through the posterior end when pupation takes place.

IMAGO. *a*, ♀. *b*, ♂.

Specimens full-fed at the end of April, produced the moth at the beginning of July.

Family GLOTTULIDÆ.

LVII.—CABRALIA TRIFASCIATA.

Genus nov. CABRALIA. Forewing elongated, triangular; costa very nearly straight, slightly arched at apex; exterior margin obliquely convex; cell extending two-thirds length of the wing; first subcostal emitted at one-third before end of the cell; second at one-ninth, bifid; fifth from end of the cell, and touching third near its base; discocellulars from angles near end of the cell, radials from the angles; middle median from near end of the cell, lower at one-fifth before the end; submedian at a wide distance from the median: hindwing triangular; two subcostals from end of the cell; discocellular bent inward near upper end, radial from near lower end; two medians from end of the cell, lower at one-third before the end. Body rather stout; antennæ filiform; palpi porrect, compact, second joint stout, third joint small and conical; legs short, stout, slightly pilose.

***Cabralia trifasciata*, n. sp. Forewing with a pale pinkish-ochreous band along the costa, another down the exterior margin, and an oblique short discal band, the interspaces being grey, the bands margined with a blackish line and bordered with white: hindwing pinkish-white. Body hoary grey; thorax with a broad pinkish collar. Expanse 1 inch.**

Larva black, with a few short very slender black hairs; each segment with four transverse dorsal prominent narrow yellowish stripes, which on the fifth to twelfth segments enclose the spiracle within a yellowish spot; front legs black; claspers, hind legs and abdomen beneath yellowish.

This is another instance of the larval form mimicking that of a Danais. (See fig. 20, plate VI.)—F. MOORE.

LARVA. *a*, Full-fed. Santo Paulo, Feb. 8, 1880.

The caterpillar was found, full-fed, on a prickly climbing plant, on Feb. 8th, 1880.

PUPA. *a*, Feb. 18, 1880.

Pupation takes place in a closely-spun cocoon, into the web of which small particles of the surrounding substances are woven, so as to make the cocoon less conspicuous.

IMAGO. { *a*, Full-fed, Feb. 8; Imago, March 5, 1880 = 26 days.

The moths appeared March 5th, being in the pupa state about four weeks.

Family APAMIIDÆ.

* L.—PRODENIA COMMELINÆ.

Phalæna Commelinæ, Smith and Abbott, Lep. Ins. Georgia, ii., p. 189, pl. 95.

LARVA.

The caterpillar feeds on cabbage, convolvulus, and some other plants. Specimens found full-fed in middle of January, 1880.

PUPA.

When full-fed the caterpillar enters the ground, and there undergoes pupation.

IMAGO.

Specimens full-fed 14th January, produced imagos on 3rd and 4th of February.

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* With this number (L) was also forwarded—

PRODENIA VARIOLOSA.

Prodenia variolosa, Walker, Catal. Lep. Het. Brit. Mus. xi., p. 722 (1857).
Prodenia cosmioides, Walker, l. c. xv., p. 1678 (1858).

This is quite a distinct species from *P. commelinæ*.—F. MOORE.

Family CALPIDÆ.

LII.—GONODONTA FULVANGULA.

Gonodonta fulvangula, Hübner-Geyer, Zutr. Samml. Exot. Schmett. figs. 737–8.

Gonodonta Maria, Guénee, Noct. ii., p. 369.

LARVA. *a*, Full-fed. Santo Paulo, Jan. 22, 1880.

The caterpillar feeds on the Araticu (Rollinia ?), and is at first black. But each change of skin alters its appearance, bright red spots appearing, and the black changing into a beautiful and intricate grey pattern.

Pupa. *a*, February, 1880.

Pupation takes place in a cocoon, which is partly formed of bits of leaf woven into the web, and sticking out in all directions.

Imago. {*a*, Full-fed, Jan. 21; Imago, Feb. 9, '80 = 19 days.
b,

The moth appears about three weeks after the caterpillar is full-fed.

Family Remigiidæ.

LI.—REMIGIA MENSURALIS.

Remigia mensuralis, Walker, Catal. Lep. Het. Brit. Mus. xiv., p. 1499 (1858).

Larva. *a*, Full-fed. Santo Paulo, Jan. 14, 1880.

These caterpillars appeared in great numbers in January, 1880, in the neighbourhood of Santo Paulo, feeding on "capim," a sort of coarse grass much grown for feeding horses, etc.

Pupa. *a*, Full-fed, Jan. 14; Imago, Jan. 28, '80 = 14 days.

Pupation takes place in a cocoon spun between the blades of grass.

Imago. *a*, Full-fed, Jan. 14; Imago, Jan. 28, '80 = 14 days.

The moth emerges from the pupa fourteen days after the larva is full-fed.

EXPLANATION OF THE PLATES.

Fig. 1* ....Plate VI ...*Danais Erippus*, larva, p. 332.
„ 2......... .. „ III ...*Morpho Hercules*, pupæ, p. 334.
„ 3............ „ III ...*Brassolis Astyra*, pupa, p. 338.
„ 4, 5, 6 ... „ III ...*Opsiphanes Glycerie*, larvæ and pupæ, p. 339.
„ 7............ „ IV ...*Acræa Pellenea*, pupa, p. 340.
„ 8............ „ IV ...*Ageronia Amphinome*, pupæ, p. 344.
„ 9............ „ IV ......*Catopsilia Philea*, pupæ, p. 345.
„ 10 .... „ IV ......*Papilio Grayi*, larvæ, p. 346.
„ 11 .... „ IV ...*Pyrrhopyga Palemon*, larva, p. 350.
„ 12, 13, 14 „ V ...*Pachylia inornata*, larvæ and pupa, p. 353.
„ 15*......... „ VI ...*Sorocaba anomala*, larva, p. 354.
„ 16 .... „ VI ...*Aneurocampa lateralis*, larva, p. 359.
„ 17 .... „ V ...*Eacles Laocoon*, larva, p. 368.
„ 18 .... „ VI ...*Megalopyge* sp., larva, p. 371.
„ 19 .... „ VI ...*Megalopyge Tharops*, larva, p. 372.
„ 20*......... „ VI ...*Cabralia trifasciata*, larva, p. 374.

* Drawn by Mr. J. Chard, Museum Draughtsman, by whom the collection has been mounted for display; all others drawn by Mr. E. Dukinfield Jones.

T. J. M.

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[Since the foregoing pages were printed off, Mr. Dukinfield Jones has returned to Liverpool, and having read over the paper, has given me the following corrections. He has also kindly replaced some of the damaged specimens of moths and butterflies by better examples. —T. J. Moore.]

Throughout the paper *for* "Santo Paulo," *read* "São" or "San Paulo."

Page 328, line 7, *after* "work," *insert* comma.

Page 328, line 14, *for* "larva," *read* "larvæ."

Page 331, line 5, *for* "Mechantis," *read* "Mechanitis."

Page 348, Papilio Lysithous is the Papilio whose metamorphoses are described and figured in the *Proceedings* of the Society for 1879-80, Vol. XXXIV., p. lxv.; plate 1; the species not having then been ascertained.

Page 352, line 3 from bottom, *for* "on," *read* "or."

Page 353, line 2 from bottom, *for* "never," *read* "woven."

Page 355, line 3 from bottom, *for* "butterfly," *read* "butterfly-pupa."

Page 361, line 14 from bottom, *for* "dark coloured," *read* "dark-coloured."

Page 366, line 2, *insert* comma *after* "back."

Page 369, line 15, *omit* comma *after* "caterpillar" and *after* "genus."

PLATE III.

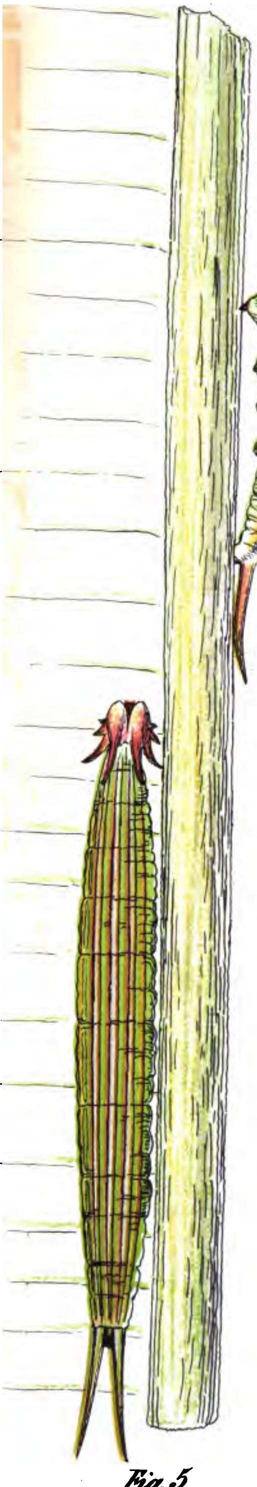


Fig. 5.

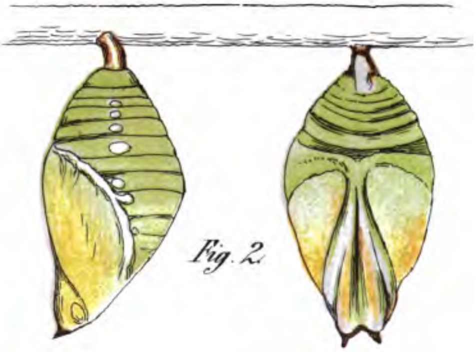


Fig. 2.

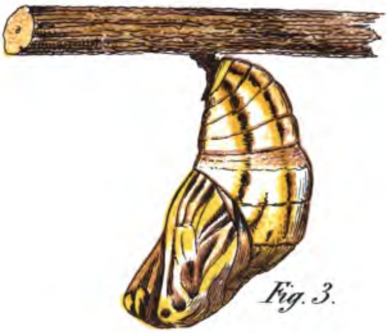


Fig. 3.

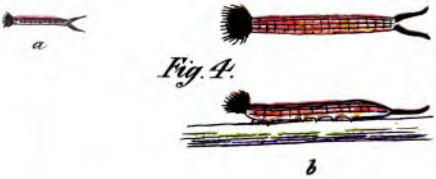


Fig. 4.

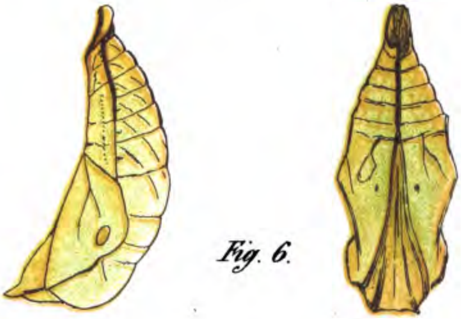


Fig. 6.

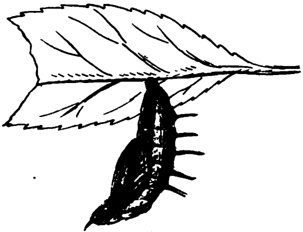


Fig. 7.

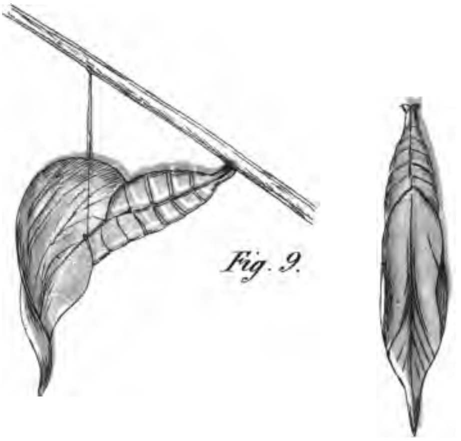


Fig. 9.

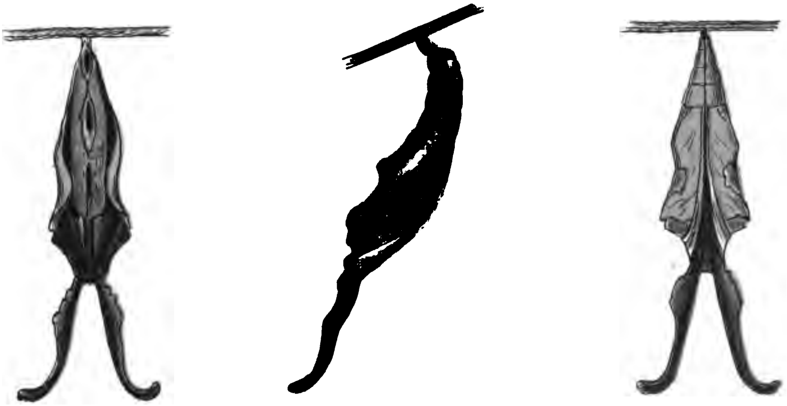


Fig. 8.

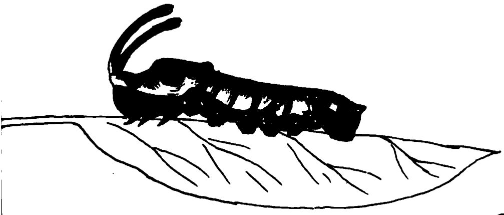
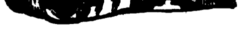


Fig. 10.



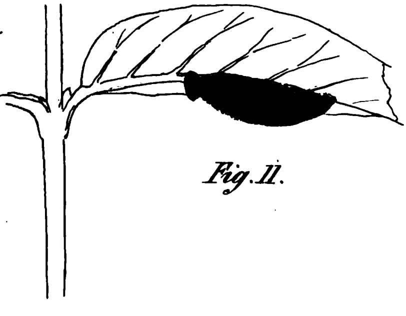


Fig. 11.

PLATE V

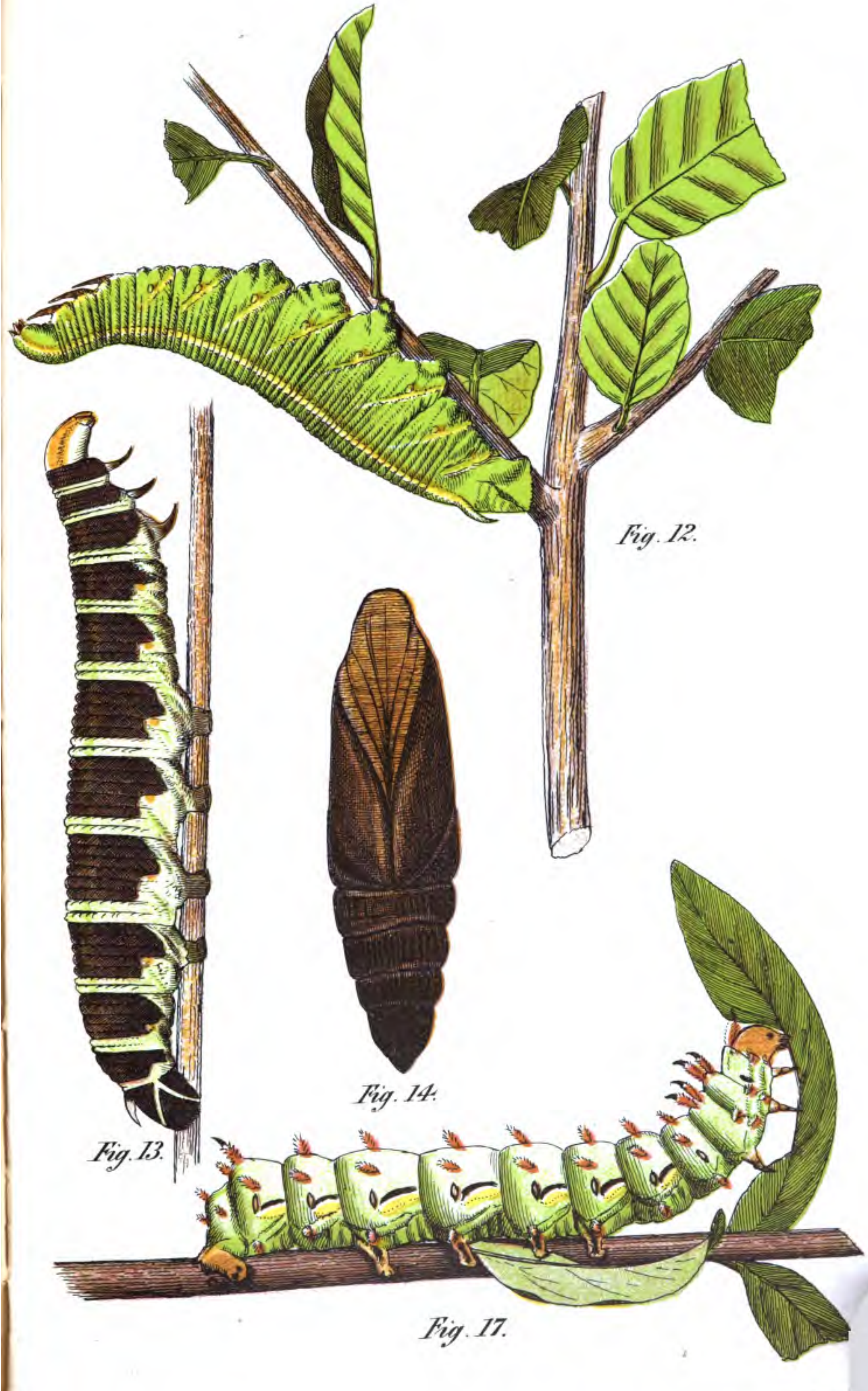


Fig. 12.

Fig. 13.

Fig. 14.

Fig. 17.